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CO-OPERATIVE SOCIETIES.

The principles on which Co-operative Societies are based are not of recent discovery, nor are they peculiar to such Societies. Everyone who becomes a shareholder in a Company is, in a sense, a co-operator, no matter how large the Company. The special feature of what has come to be known as the co-operative movement is that it links together for the purposes of buying, or selling, or lending money, individuals whose separate capabilities in any of these respects are for all practical purposes negligible.

The earliest Co-operative Societies were formed for the supply of goods for ordinary household requirements. Collective buying cheapened the purchase. The movement was necessarily confined to the towns, as it was essential that a sufficient number of consumers should be found in a limited area. From small beginnings, there has arisen in England an organisation which owns, not only a network of shops but also various sources of production, and in the magnitude of its operations rivals any "capitalist" concern.

The idea of co-operation has now spread, until there are, especially on the Continent of Europe, very few phases of activity in agriculture which are not represented by a Co-operative Society, whether for collective selling or collective buying, or united effort in improvement of crops or stock.

The objects of the majority of these Societies may be classed as collective trading; and a member of such a society expects to get an immediate return either in the lower price of the goods he buys or the higher price of what he sells.

Later came the idea of Co-operative Credit, which is the combination of "small men" to lend money for productive purposes. It is banking on a minor scale, with security which the professional banker cannot handle. It is unnecessary to detail here how its special difficulties are overcome. It is, however, now an accomplished fact. But it is obvious that its benefits cannot be immediate to every member (except where outside assistance is given), and it demands at first a certain amount of altruism on the part of some.

In Ceylon, the evolutionary sequence of the Co-operative movement has been reversed. It began with the formation of Co-operative Credit Societies, formed with the object of lending money for productive purposes. Subsequently there arose a demand for Co-operative Societies for the purchase of manure, or for the collective selling of produce, or for general supply, and the original Co-operative Credit Ordinance has been expanded into the Co-operative Societies Ordinance, which legalises other than Credit Societies.

It is, however, important that the difference between a Co-operative Credit Society and a Co-operative (trading) Society should be borne in mind.

A Co-operative Credit Society deals only with money. It lends money, with sureties as security. The borrower is presumed to use the money for some purpose which will enable him to repay the loan and yield a profit for himself. In the case of failure of crops, the loss falls on the borrower, not the society. The society has no stock to deteriorate. Its chief concern is to keep its capital intact.

A trading society, on the other hand, has to take some business risks. It may invest in goods which deteriorate or become unsaleable; or it may purchase too optimistically and be unable to sell at a profit. Experience has shown that, with the necessary precautions, a Co-operative (trading) Society can be managed without undue losses, yet nevertheless it has also shown that the two phases of Co-operation, Co-operative Credit and Co-operative Trading, should be kept distinct. One society cannot combine both objects.

We may recall that, prior to the passing of the Co-operative Credit Ordinance of 1911, a Credit Society was formed in a certain district in Ceylon and proved very successful. Unfortunately, it undertook tobacco growing, and, the crop that year happening to be a failure, the society lost all its capital and ceased to exist.

RUBBER.

"RUSTINESS" OF SMOKED SHEET RUBBER.

SOME MEANS OF PREVENTION.

The defect of smoked sheet rubber, known as "Rustiness", may be defined as the reddish-brown powdery deposit on the surface of smoked sheet which generally becomes visible only when sheets possessing this defect are stretched and allowed to retract. Such sheets are said to "stretch rusty". This defect has been a source of trouble to rubber estates for many years, and while it is a moot point whether the presence of "rustiness" has any detrimental effect upon the intrinsic physical properties of the rubber after vulcanisation yet the rubber buyers take advantage of its appearance in a consignment of smoked sheet to assess the value of that rubber at a lower price than they would have, had the "defect" been absent. It therefore behoves rubber planters to take every care that this defect does not appear in their output.

It was first considered that "rust" was due to the deposition of substances contained in the serum, after the coagulation of the latex, on the surfaces of the sheets upon the evaporation of the water portion of the serum. MORGAN in the 1922 edition of his well-known book "THE PREPARATION OF PLANTATION RUBBER" states that: "It will now be clear that 'rust' is caused by a film of matter which is formed on the surface of the pressed coagulum, being there deposited by the exudations from within the rubber through the pores." Research work carried out in Java by HELLENDOORN (ARCHIEF VOOR DE RUBBERCULTUUR. Vol. 3. Page 412), however, has shewn that "the film of serum substances, notably proteins, dried up on the surface of the sheet" explanation of the origin of "rust" was not due to the deposition of the residual substances from the serum on the surface of the sheet but to the decomposition of those substances, which decomposition was brought about by the activity of aerobic micro-organisms. He found that the presence of these protein substances on the surface of the sheet did not produce "rust" when the sheet was dried and smoked provided that he could prevent these surface deposits from being acted on by the micro-organisms. This he did by soaking the sheet in some disinfecting fluid such as dilute solutions of formalin, chinosol or sodium bisulphite prior to hanging the sheet out to dry.

THE CEYLON RESEARCHES.

Corroborative experimental work on the occurrence of "rust" on sheet rubber has been recently carried out in Ceylon and this fully substantiates the conclusions of HELLENDOORN. Both HELLENDOORN and the scientists of the Rubber Research Scheme of Ceylon carried out some most interesting experiments in connection with this matter and from the results of which points of great practical importance were obtained. The following are some of the main points brought out by the experiments.

"Rust" on sheet rubber can be produced at will irrespective of the method of manufacture (*e.g.* scrubbing with hot water after the sheet has left the marking machine, soaking the sheet in water for a length of time). All that is necessary is to keep the freshly made sheet in a damp condition for some time and "rusts" will develop. Experiments in which freshly made sheets were hung in a damp chamber (a kerosene tin containing a little water at the bottom) for periods of one and two days never failed to produce "rust", the degree of "rustiness" increasing with the longer period. If, however, the water in the damp chamber was replaced by formalin solution (2 %) and a freshly prepared sheet again hung in this atmosphere of formalin vapour no rustiness developed.

It was suggested that since the formalin vapour has a hardening effect upon the surface of the sheet this freedom from "rust" might be caused by this action and not by the disinfecting effect of the vapour. The Ceylon workers therefore replaced the formalin with a 5 % solution of potassium cyanide so that the freshly made sheet was hung in the vapour of the disinfectant substance. Again no "rustiness" appeared on the rubber.

COAGULANTS AND "RUST".

HELLENDOORN found that the micro-organisms which caused the decomposition of the serum substances and thereby produced "rustiness" needed air for their existence (*i.e.* they are aerobic). He found that if a freshly prepared sheet was tightly rolled up and placed in a moist atmosphere then only those portions exposed to the air developed "rustiness". The workers in Ceylon investigated whether the extent of the dilution of the latex used in sheet making and also the amount of acid employed for coagulation purposes had any bearing upon the occurrence of "rust." They found that there was distinctly less rust upon the sheet prepared from undiluted latex but that the amount of acid employed did not appear to contribute to the question of "rust" formation. The former of these findings appears to be diametrically opposed to the suggestion given by MORGAN that the richer the latex the greater the percentage of protein retained in the coagulum and hence the greater the probability of the occurrence of "rust". Even abandoning the "deposition of serum substances" theory for the origin of "rust" and the adoption of the micro-organism idea it is difficult to suggest a reason for the finding that distinctly less "rust" was found on sheet made from undiluted latex, provided that all other factors (*e.g.* temperature and humidity) were equal.

Both HELLENDOORN and the Ceylon scientists found that "rustiness" was increased by delay in rolling the sheet after coagulation. Where the coagulum was rolled two hours after coagulation was complete the resulting sheets produced less "rust" than in the case where the coagulum was rolled the next morning when both sheets were hung in similarly damp atmospheres.

WASHING OF SHEETS.

In view of the fact that the washing of sheets as soon as they have been through the marking rollers either in warm or cold water has been advocated as a means of preventing "rustiness" on the grounds that much of the serum substances which would otherwise be left on the surface of the sheet are thereby washed away, the results of the experiments in which

sheets were soaked in water for some time are of interest. HELLENDOORN's experiments led him to state definitely that "soaking in water does not prevent rustiness, and that after soaking in water rustiness develops even to an increased degree". The workers in Ceylon found that sheets soaked in running water for four hours and then hung up in the damp chamber developed heavy rust though to a slightly less extent than in the case of the control which had not been washed. They did not find, like HELLENDOORN that the soaking in water increased the tendency to "rust" formation.

THE TEMPERATURE QUESTION.

The question of temperature is an important one in the formation of "rust" on sheet. HELLENDOORN found that the optimum temperature for the growing of the micro-organisms was around 104°F. By, maintaining the damp chamber in which the piece of sheet rubber was hung at this temperature he succeeded in obtaining rustiness to the maximum degree. On raising the temperature to 120°F. he failed to produce the "rust" and he therefore considers that this temperature is too high for the growth of the micro-organisms.

A consideration of what has been written above will indicate to rubber planters what steps they should take to prevent the defect "rust" from affecting their sheet rubber. Since "rustiness" is the result of the action of micro-organisms upon the surface of the drying sheet rubber it is obvious that "rust" can be prevented by preventing these micro-organisms from working. This can be best attained by rendering the surface of the sheet rubber an uncongenial habitat for these organisms either by covering the surface of the sheet with some substance noxious to these organisms or by rendering the conditions existing on the surface of the sheet unsuitable for their existence.

MEANS OF PREVENTION.

HELLENDOORN has shown that by soaking freshly made sheet in dilute solutions of formalin, chinosol or sodium bisulphite for some time and placing such treated sheet under conditions which would produce "rustiness" in untreated sheet, the treated sheets do not develop the defect. This method can be adopted by estates as a practical means of preventing "rust" but in view of the fact that it is not so efficient as the method next described, and further as it entails additional work and expense it is not recommended.

The alternative method, which is strongly recommended for adoption by all estate managements, irrespective as to whether they are or are not troubled with the defect "rust", utilises the other means suggested above for rendering the surface of the sheet uncongenial to the "rust" causing organisms, *viz.* by so adjusting the conditions that they are unfavourable to the development of the organisms. Moisture is essential to these organisms for their development, and if one can so hasten the surface drying of the sheet, when freshly made, that the organisms have no time to develop then "rustiness" will never occur. Quick surface drying is the secret for the prevention of rust on sheet rubber, and a careful watch should be kept for anything in the factory procedure which may prevent this from being obtained. The sheets after rolling and marking should be hung out in the open to drip and surface dry. They should not be hung up in a dark

corner of the factory to drip, as here the rate of surface drying is so slow that the organisms have plenty of time to establish themselves before the sheets have finished dripping. Ordinary sheet rubber (made from latices of $1\frac{1}{4}$ to $1\frac{1}{2}$ lb. rubber content per gallon and properly rolled) should be surface dry in about two to two and a half hours (in fine weather) if the place chosen for their hanging is a suitable one. Care should be taken to see that the wet freshly made sheets do not overlap when they are hung out to drip. If attention is not paid to this matter the places on the sheets which touch remain moist after the remainder of the sheet's surface is dry and "rust" may occur in these portions of the sheets. Not only must attention be paid to the matter of the sideways overlapping of the sheet but also to that of the vertical overlapping of the sheets of different rows. "Rusty" ends of sheets are caused often by neglect of this point. After the sheets have become surface dry they should be taken at once and hung in the smoke-house.

AN EASY METHOD.

In most factories it would be generally very inconvenient, and would entail a considerable loss of time, were each individual sheet taken and hung out in the open as soon as it left the marking rollers. To prevent this loss of time the sheets after leaving the marker may be laid on edge against an upright piece of board firmly fixed on the table until a sufficient number of sheets have been collected to justify the cooly making the journey to the hanging racks outside. The placing of the sheets on edge (as opposed to stacking them up in piles when they leave the marking rollers) permits a more or less easy running off of the surface water from the sheets, which cannot take place when the sheets are piled up one on top of the other. On no account should wet sheet be allowed to remain piled up in the factory, at least for any length of time. It must be pointed out that the edge draining, suggested above, of the sheets cannot and should not be employed as a substitute for the hanging of the sheet in the open. On some estates it is the usual practice to leave the sheet lying about the factory until the whole crop has been marked and then to weigh the rubber. This practice offers every opportunity for "rust" to develop. As freedom from this defect is of more importance than a knowledge of the weight of the previous day's output it is suggested that the weighing of the rubber could be postponed until after the surface drying is completed and before the sheets are placed in the smoke-house.

The above described method of dealing with the sheet to prevent "rust" is easy to carry out where the crop is made up the next morning, for then with a properly equipped factory the sheet can all be surface dried and ready for the smoke-house by 11 a.m. The wet sheets can be hung to surface dry in the sun up till about 9 a.m., or 9.30 a.m. at the latest. By allowing the sheets to remain in the sun until a later hour one runs the risk of glossy "bar-marks" appearing across the sheets due to the heat causing a slight tackiness at those parts.

TWO SOLUTIONS.

Where the sheets are made up the same afternoon, certain difficulties arise in bringing about the desired quick surface drying. If sheets are hung out in the open late in the afternoon the rate of drying will be usually

extremely slow and "rustiness" on the surface will be nearly unavoidable. Further, it would be fatal to leave the sheets in the factory until the next morning, either stacked up or laid on edge. Two solutions however offer themselves whereby the micro-organisms are prevented from establishing themselves upon the surface of the sheets. The first is to keep the freshly made sheets under water all night, and then to hang them out in the open first thing the next morning. As the micro-organisms need air for their existence they will not be able to infect sheets when under water. Further, this soaking of the sheets, caused thereby, decreases the chance of mould growths upon the sheet after smoking and also the occurrence of that greasiness of the sheet which sometimes is found.

The other solution to the problem is by having a small special "first night" smoke-house in which the wet sheet can be hung. Provided that a good supply of smoke and heat (but not too much heat) is available, no opportunity should be given to the micro-organisms to affect the sheets under these conditions. The question might be raised however, that if it is suggested that the sheet should be hung in a smoke-house, then why should one go to the trouble of erecting this special "first night" building and why should not the sheet be hung straightaway in the ordinary smoke-house. The answer to this question is that it is extremely inadvisable to bring dripping sheet (and that means water) into the ordinary smoke-house. Such water has to be evaporated, which means utilisation of heat, so that the temperature of the whole building is kept lower than it otherwise would be until all the water has been vaporised. Further, this water vapour goes into the atmosphere of the building and helps to bring about its saturation. As the drying sheets are now surrounded by a moisture laden air the general rate of drying is reduced. This result is accentuated if the building is insufficiently ventilated. Presuming that the fires are allowed to slow down during the night then the building will cool and some of the water vapour contained in the saturated atmosphere will condense out on the walls of the building and on the hanging sheets. This will assist greatly in the growth of mildews on the sheets and also contribute towards the creosote drippings from the roof and beams which are sometimes found disfiguring sheet rubber. A further point needs consideration in connection with the hanging of the dripping sheet in the ordinary smoke-house. The fires could not be lighted until the freshly made sheets were hung up and as it would take some time before the general temperature of the large building would be high enough to inhabit the growth of the micro-organisms (120°F.) every opportunity would thus be given to the organisms to grow on the wet surfaces of the newly made sheet. Indeed, for some space of time, the length of which depends upon the style of smoke-house, the temperature under which the newly made sheets would exist would be the optimum for the development of the "rust" causing micro-organisms (104°F.). It will be therefore concluded from the above that the hanging of wet dripping sheet in the ordinary smoke-house is not advisable. Certain estates do put their freshly made wet sheets direct into the smoke-house and appear to suffer none of the consequences suggested above. Their immunity from these consequences may have been brought about by the fact that their smoke-houses are well ventilated and are of those types which are quickly heated up. (*The Planter.*)—PLANTERS' CHRONICLE, Vol. XIX. No. 21.

THINNING OUT RUBBER.

In thinning out rubber on a scientific basis, two methods are open, *viz*—thinning in accordance with yield, or thinning in accordance with the number of latex vessel rows. The first method is the more obvious one, but it requires the determination of the individual yields of the trees at intervals over a period of a year or more in order to avoid chance fluctuations. The second requires only one examination of each tree, and probably for that reason there was a tendency to regard it as the only practicable method when it was first proposed. But it has serious disadvantages. As was pointed out in Ceylon some years ago, in thinning out by yield, some trees are retained which are good yielders, but have few latex vessel rows, whereas in thinning out by latex vessel rows some trees are retained which have a large number of latex vessel rows, but are poor yielders. That is due to the fact that the yield and the number of latex vessel rows vary independently of one another, and it is readily seen to be an inevitable conclusion when a correlation table of the yields and numbers of latex vessel rows is constructed for any group of *Hevea* trees. It is indisputable.

It has been urged that it is preferable to retain the smaller yielders with a large number of latex vessel rows, in preference to the good yielders with few latex vessel rows, because the yield of the former may improve after the thinning out, and the latter may be the more liable to develop Brown Bast. These are still speculations; or rather, the evidence since obtained does not support either. The recorded examinations of trees affected by Brown Bast do not show any relation between the incidence of Brown Bast and the number of latex vessel rows.

Accounts of the results of thinning out by these two methods are now being published, the most recent contribution being a paper by DR. W. BALLY in the ARCHIEF VOOR DE RUBBERCULTUUR for June 1924, entitled "Over de waarde van bastonderzoek en van productie-opname voor het uitdunnen van rubbertuinen."

In 1920, ARENS determined the numbers of latex vessel rows of the trees in question, and thirty yield determinations were made during that year. Further yield determinations were made in 1921 and 1922: and in the latter year the plots were thinned out. After the thinning, yield determinations were made in 1922 and 1923, and bark examinations in the latter year, by DR. BALLY.

The trees were divided into six plots, three of which were thinned out according to yield, and three according to bark examination. The standard was not the same on all the plots. On G 1, the trees were reduced from 69 to 49, all yielding less than an average of 6 grams wet crepe per tapping (29 per cent. of the trees) being removed; on G 3, the trees were reduced from 139 to 101, (27·3 per cent.), the standard being 6·4 grams wet crepe; and on G 5, from 129 to 90 (30·2 per cent.), the standard being 4·5 grams wet crepe per tapping.

In the second series, the trees on G 2 were reduced from 97 to 74 (23·7 per cent.), all having 9 or fewer latex vessel rows being removed; on G 4, the trees were reduced from 131 to 103 (21·4 per cent.), all having 7 or fewer latex vessel rows being removed; and on G 6, from 149 to 106 (28·8 per cent.), all having 9 or fewer latex vessel rows being removed.

In an experiment of this nature, it must be impossible, except by some extraordinary combination of chances, to obtain uniformity of conditions. One cannot expect to have all the plots thinned out in the same proportion, and at the same time adopt a uniform standard of yield or latex vessel rows. Perhaps, if the object of the experiment is to compare yields before and after thinning, it would be preferable to thin out all plots in the same proportion; and it may be noted that more trees could have been spared in G 4, from the point both of percentage thinning and of standard of latex vessel rows.

There are, however, more serious objections to the experiment. As DR. BALLY points out, it is an estate experiment, and it has been subject to the usual vicissitudes which attend such experiments. Before the thinning, the trees were tapped by a V cut daily; after the thinning they were tapped by a single cut on a half on alternate days. Some trees were tapped for a short time on one-third circumference. Further, before the thinning, the cuts on the trees were at different heights; it was only after the thinning that care was taken to have the cuts on all trees at approximately the same height.

It follows that no comparison can be made of the yields of the trees before and after thinning. The differences in yield due to inequalities in the heights of the cuts before thinning may have been averaged out by the large number of yield determinations made, so that comparisons of the trees *inter se* before thinning out are valid; and the comparisons similarly made after tapping are valid. But it is not possible, owing to the variation in the tapping system, to compare the yield before thinning with the yield after thinning.

It might be suggested that a comparison of the percentage increases of the yields after thinning would afford some measure of the relative value of the two methods. This, however, is not possible, as the trees were not thinned out equally in the two cases.

We have directed attention to this aspect of the experiment, because it is illustrative of a large proportion of the investigations which have been published during recent years. In very many cases, the investigation is based on routine estate work, and it is subject to the inevitable variations which occur when experimental work must give way to estate practice. In some instances, as in the present case, the imperfections are recorded by the investigator; in others, they are obvious to anyone who studies the account carefully. It is open to question whether it is worth while to publish accounts of such investigations. They have their value, in affording "pointers" for more accurate work, and hence would serve a useful purpose as laboratory records; but if published they are apt to be misleading. The author may record all the facts which make the results inconclusive, but it is usually found that all such qualifications are discarded on quotation.

DR. BALLY'S conclusions relate chiefly to facts determined from the examinations of the individual trees. He finds that there are some trees which are good yielders and have few latex vessel rows, and that these remain good yielders for a long time. This is in accordance with the view that a good yielder is always a good yielder, apart from the question of disease. If the plots had been thinned out in accordance with bark examinations only, these trees would have been cut out; hence yield determinations are indispensable.

Again, he states that some of the trees which were poor yielders but have a large number of latex vessel rows, show an increased yield after thinning out. Consequently, if the selection had been made according to yield, the real qualities of these trees would not have been ascertained and they would have been cut out. Hence he concludes that bark examination, *i.e.*, counting the number of latex vessel rows, is just as indispensable as yield determinations.

The latter conclusion does not appear to be warranted. The bark examination has, of course, to be made before thinning out; and it is impossible for anyone to predict which of the poor yielders with a large number of latex vessel rows are likely to become good yielders after the thinning. The only evident use of bark examination in this connection would be in a case in which it was desired to remove some of a number of trees which gave approximately the same yield. In such a case one would naturally retain those which showed the greatest number of latex vessel rows. But if poor yielders with a large number of latex vessel rows are to be retained (in preference to good yielders with few), in the expectation that they will become good yielders, it will be necessary to discover some criterion which will indicate not only those trees which are certain to show improvement, but also the extent of that improvement; for it is essential that their increased yield due to the amelioration of environmental conditions after thinning should exceed the yield of the good yielders under the same conditions. In the present state of our knowledge, it does not seem probable that any such criterion will be forthcoming.

However, Dr. BALLY's conclusion does not appear to be supported by his facts. He cites as examples of the improvement in question the trees G II 16, G. IV 77, and G V 77. But he also gives a list of the good yielders which have few latex vessel rows, with a table of their average yields, and another list of the poor yielders which have many latex vessel rows, with a similar table. From these it is evident that the yield, before thinning, of G II 16, which is classed as a good yielder with many latex vessel rows was greater than (approximately equal to) that of G II 5, which is classed as a good yielder with few latex vessel rows. Similarly, the yield of G IV 77, another poor yielder with many latex vessel rows, was greater than that of either G IV 50, G IV 85, or G IV 126, all of which are classed as good yielders with few latex vessel rows. And again, G V 77, an alleged poor yielder with many latex vessel rows, yielded more before thinning than G V 43, an alleged good yielder with few latex vessel rows. Hence it would appear that the conclusion in question was based upon trees which had been placed in the wrong class.

DR. BALLY finds that there is no correlation between the diameters of the latex vessels and the yield. The larger yield of certain trees which have few latex vessel rows is not due to a greater size of the latex tubes.

As is well known, trees with the greatest number of latex vessel rows do not necessarily give the greatest yield. DR. BALLY finds that after thinning out, the discrepancy becomes more marked. Consequently any subsequent thinning must be based on yield.

DR. BALLY's paper does not afford any evidence which conflicts with the advice hitherto given in Ceylon, that selection should be based on yield.

BORERS IN HEVEA.

L. G. E. KALSHOVEN, of the Instituut voor Plantenziekten, Java, has begun an investigation into the attacks of boring beetles on standing *Hevea* trees. These attacks have been well known for many years, and a full investigation of the conditions under which they occur has been long overdue.

The preliminary account, in the ARCHIEF VOOR DE RUBBERCULTUUR, VIII, No. 6 (June 1924) deals chiefly with the species of beetles found in *Hevea* stems and branches. These are similar to the beetles found in the same situations in Ceylon. They belong to two families, the Scolytidae and the Platypodidae. KALSHOVEN calls them sapwood borers, because they bore into the wood while it is still wet; this scarcely agrees with the English usage of the term. Among them is the well-known *Xyleborus perforans*, so common in canker patches on *Hevea* and cacao, to which the cacao canker of Ceylon was attributed when it first appeared.

In dead and dry *Hevea* wood, beetles of other families may be found, but these are not of interest to the planter. It may be noted that the investigator does not appear to have met with *Batocera rubus*, the root and stem borer of *Hevea*.

KALSHOVEN states, as a result of his preliminary observations, that beetle attacks may occur

(1) on trees which for some reason or other are dying or declining,
(2) on wounded or diseased parts of the stem,
(3) on apparently sound parts of the stem.

Under the first heading he includes trees which are dying as a result of an attack of root disease, or after having been struck by lightning; and under the second, trees attacked by canker or pink disease.

With regard to the third, which is the really important case, he remarks that in most cases in which beetles are reported to have attacked sound trees the insects are really secondary, following on a previous injury, and suggests that such a mistake can easily be made in cases of trees struck by lightning. He notes that it has been repeatedly observed that beetles which have been attracted to local injuries on the stem sometimes bore into healthy parts of the bark and are fixed by the issuing latex.

Nevertheless, he considers that, judging from what occurs in other trees, a primary attack by borers on a "practically quite sound" *Hevea* tree, is not out of the question. Such cases, he thinks, may occur when a large number of borers are bred in dead or felled rubber. On emergence, these borers may attack the healthy trees in the neighbourhood, usually unsuccessfully, because they are trapped by the flow of latex. This hypothesis was put forward in Ceylon several years ago.

It will be evident that the article under review does not carry us much beyond what has been known for the last ten years. One very striking feature which requires elucidation is that while beetles readily, and in large numbers, attack trees killed by lightning, die-back, or canker, they seldom attack tapping wounds, or wounds deliberately made by cutting out large pieces of healthy cortex. The explanation is probably simple, and may depend on the attractive odour of cortex which is decaying as a result of a

fungus attack, or which is undergoing a *post mortem* fermentation. Parallel to the above is the observation that if trees are lightly scorched by fire they are quickly attacked by beetles, but if the scorching is so severe that the bark is charred, they are not, or comparatively slightly, attacked.

Another unexplained case which occurred fairly frequently a few years ago is that of the attack of borers on renewing bark after the application of liquid fuel. The affected patches were, as a rule, very small, and usually contained a single borer hole. It is possible that the bark may have been killed by the liquid fuel, but even in that case its penetration by boring beetles would not have been expected.

Pink disease and canker frequently affect only the outer layers of the cortex at first, and a beetle which bores through the diseased tissue may penetrate into the underlying sound cortex, and be smothered by the outflowing latex. But that does not explain all cases in which beetles are found fixed in their bore holes by rubber. It is possible that the hypothesis already referred to may afford the explanation, but it seems somewhat at variance with the known habits of these insects.

It may be worth while to recall one case, which has previously been recorded elsewhere. On a certain estate, where the trees had been thinned out and the felled trunks had probably induced an excessive multiplication of borers, large numbers of insects were found on the healthy standing trees, partly embedded in shallow bore holes, with the hinder half sticking out. In none of the instances examined had the insect bored into the cortex far enough to tap the latex tubes. It had penetrated as far as the stone cell layer and had then died, and the tree had subsequently blocked the inner end of the boring by a layer of cork. Why the beetles died remains unexplained.—T. P.

COST OF RUBBER PLANTING IN SUMATRA.

The following figures are taken from a carefully prepared estimate of the cost of planting and bringing into bearing of a rubber estate in Sumatra, but the estimate represents also, with fair accuracy, the expenditure necessary on a similar proposition in Malaya.

The minimum area taken for economical working is 2,000 acres. Company formation expenses are not included, but 5% interest on capital is allowed, up to and including the fifth year.

The cost includes the wages of 500 coolies, and the salaries and bungalows of the European Staff.

The cost per acre to the end of the fifth year works out at £83.16.8 but as the cost of production is high of young rubber just coming into bearing, it is suggested that a further allowance should be made for interest on capital until the seventh year, and £100 per acre is a fairly accurate estimate for planting and bringing into bearing of a rubber estate in Sumatra at the present day.—INTERNATIONAL REVIEW OF SCI. & PRAC. OF AGRICULTURE. Vol. II. No. 1.

COCONUT.

COCONUT FIBRE AND YARN INDUSTRY.*

BY DR. A. J. KLUYVER AND R. M. I. REKSOHADIPRODJO.

(*Translated from the Dutch by H. L. Ludowyk, Librarian, Department of Agriculture, Ceylon.*)

CHAPTER III, COCONUT CULTIVATION IN CEYLON. ORIGIN AND DEVELOPMENT.

Although recent research has made it seem probable that the original home of the Coconut was South America† and that it reached Ceylon *via* Eastern Asia, it is a well-established fact that the cultivation of coconuts in Ceylon dates back at least as far as the beginning of the Christian era. FERGUSON in his important article "The Beginning, Rise and Progress of the Cultivation of the Coconut Palm in Ceylon"‡ points out that the Roman writer ÆLIANUS in the second century of the Christian era makes mention of the existence of regularly laid out coconut plantations along the southern coast in the neighbourhood of Galle. It is strange however, that in the MAHAWANSA, the ancient Sinhalese annals of Ceylon, there is but one reference to the coconut, whilst, on the other hand, references to the Palmyrah (*Borassus flabellifer* L.) are numerous.

There occurs a passage in this book which tells us that about the year 589 A.D. KING AGGRABODHI caused a coconut plantation to be laid out over an extent of land thirty English miles long, probably between Weligama and Dondra on the Southern Coast of the Island. Repeated references are to be found to support the fact that in the next century coconuts and arrack were export products of Ceylon, showing thereby that coconut cultivation was increasing in importance in that country. The statement of the MAHAWANSA which has been just referred to is strongly corroborated by the fact that about the year 1250 KING PRAKRAMA BAHU II. caused the coastal strip between Bentota and the Kaluganga to be planted with coconut palms. In the course of centuries the coconut palm kept on spreading further over the Island, chiefly, and at first, along the south and the west coasts. However, the spread of the cultivation must have taken place rather slowly, for already in the year 1740 the Dutch Governor VAN IMHOFF took the initiative for

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* KLUYVER, A. J. en REKSOHADIPRODJO, R. M. I. Klappervezel—en Klappergarennijverheid: Verslag v, een opdracht v.h. Kolonial Inst. ingesteld onderzoek naar de Klappervezelindu strieen op Ceylon en an de Malabarkust met een beschouwing over de mogelijkheid deze industrieen in Nederlandsch Oost—Indie ingang te vinden. Kolonial Inst. Amsterdam Meded. No. XX, Afd. Handels museums No. 5.

† Vide: COOK, O. F. History of the Coconut Palm in America. Contrib. from the U.S. Nat. Herbarium Vol. XIV. Pt. 2. Washington, 1910. The foundation of COOK's theory has been rather shaken by the spontaneous appearance of the coconut on the Island of Krakatau after its entire vegetation had been destroyed in 1883. Compare with W. DOCTERS VAN LEEUWEN. Proc. of the First Ned. Ind. Natural Sci. Congress, Weltevreden, 1920, p. 44.

‡ *Journ. Royal Asiatic Society Ceylon Branch, Vol, XIX, 1906. p. 22.*

attaining the aim he had in view of planting the south-western littoral from Colombo to Kalutara with the coconut palm. This part of the Island is now the most important centre of coconut cultivation.

About the year 1800 the south coast and the southern part of the west coast of Ceylon were characterised by the presence of complete stretch of almost forest-like plantations of coconut palms. These plantations, however, did not stretch very far inland from the coast.

Especially under the influence of the English colonists (*sic*), in the latter half of the nineteenth century, a great impetus was given to the spreading of the cultivation and many important areas were opened up. According to FERGUSON* the area planted with coconuts had, since the beginning of 1840, been increased by at least seven-fold. The first systematically planted coconut estates opened out by the English were all in the Jaffna and Batticaloa districts, but the most extensive areas were opened up later in the Negombo, Chilaw and Puttalam districts all of which lie North of Colombo. Further, thousands of acres of land occupying the valley of the Maha Oya were also planted with the coconut palm. Besides the ancient plantations of the Sinhalese people along the coasts of the Southern and Western Provinces, there also exists to-day a very important cultural district in the North-Western Province, particularly in the land lying around the mouth of the Maha Oya, the districts of Puttalam and Kurunegala. The smaller districts around Jaffna in the North, Trincomalie and Batticaloa on the east coast ought to be mentioned.

It should, however, be stated that although at first the lands referred to were opened up wholly under European guidance and also with the help of European capital (*sic*), at the present time the rather rich and influential Sinhalese have brought under cultivation very important tracts and established systematic coconut plantations. And these plantations have so spread and reached such an advanced state of cultivation that the coconut estates in the Western and the North-Western Provinces which belong to the Sinhalese owners very often surpass the English estates.†

Generally speaking coconut cultivation in Ceylon is restricted chiefly to the areas that receive annually a rainfall of 50 inches at least: the plantations in districts receiving 75-100 inches, however, flourish better. But in places where the land is regularly covered by innundations of rivers, or where a rich soil is to be found, the palm can be cultivated with success when the annual rainfall is even 40-50 inches.

It is very difficult to form a just estimate of the acreage under coconut cultivation in Ceylon, as a large number of trees that cannot be neglected in the computation grows in the small and widely scattered native gardens. On this point the authorities on the subject are nearly unanimous in fixing the extent of the surface of the Island planted with coconut, all included, at between 800,000 and 900,000 acres.

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* *Coconut Planters' Manual or All about the Coconut Palm*, 4th Ed., Colombo, 1907, p. 3.

† The Sinhalese who have interest in coconut palm cultivation are united in the flourishing "Low-country Products Association" at Colombo. Besides the Sinhalese there are also "Burghers" (the descendants of the old Portuguese and Dutch colonists) who are members of the Association that does much to further the interests of coconut cultivation in Ceylon,

THE CEYLON HANDBOOK and DIRECTORY for 1919-1920 on pages 641-706 gives statistics of the different coconut estates and the acreage of each estate is given. By casting up the data therein given we have been able to arrive at the figures given in Table I, showing the number of acres of coconut plantations in each province. Close examination of this list shows that the area of the scattered but important (from point of view of total extent) native gardens has not been taken account of in the reckoning.

TABLE I.

Area Planted with Coconuts in Ceylon.

(Estates).

Province.	*Acreage.*
North-Western	112,400
Western	76,674
Southern	22,926
Sabaragamuwa	4,955
Eastern	17,926
Northern	19,645
Central	7,493
North-Central	600
Total	260,619

These figures show clearly how keenly modern coconut cultivation has been pursued in the Island especially in the North-Western and the Western Provinces. Nevertheless this table is not a sure guide for gauging the relative importance of the cultivation in the different provinces. When the acreages of the small and scattered gardens of the Southern Province are also computed we find that the total amounts up to about 100,000 acres while, on the other hand, in the Northern Province (Jaffna district) and in the Eastern Province (Trincomalie and Batticaloa districts) the number got by the addition of the acreage of the native gardens would but slightly alter the figures quoted in table I.

BELFORT and HOYER are of opinion that there is but very little land more in Ceylon that is suitable for the cultivation of coconuts, so that there is but little scope for the spread of the cultivation further in the Island.*

Nevertheless the possibility of opening up and cultivating the wide tracts of land in the "dry zone" towards the North and East of the Island under wide and efficient irrigation systems has not to be lost sight of.

Important experiments on these lines have already been carried out by the Government Agricultural Department.†

If we take the acreage in Ceylon planted with coconuts to be what authorities generally place it at, 800,000, then taking into consideration that there are on an average 80 trees per acre—a moderate estimate in view of the fact that the people generally plant their trees very close—the total number of coconut trees in the Island according to the results of calculation with these approximate data would be 64,000,000.

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* BELFORT and HOYER. *All about Coconuts, London., 1914.* P. 35.

† See for example: G. HARBORD. *Coconut Trials in the North-Central Province.* Bul. No. 7, Dept. of Agric., Ceylon, 1913.

Placing the annual produce per tree at 25 nuts we conclude that annually there is a harvest of 1,600,000,000 coconuts in the Island of Ceylon. But in reality the number of nuts harvested is considerably smaller since a considerably large percentage of the trees bear no fruit at all as they are utilised for the purpose of extracting toddy by the tapping of the flower spathe; and this toddy is used to manufacture arrack.* In view of the decrease in the crop due to tapping, the annual harvest may be estimated at a total of but 1,200,000,000 nuts. Of this crop at least 700,000,000 nuts are used up for home consumption annually, and 500,000,000 nuts, chiefly those harvested on large estates, are utilised for the purpose of manufacturing articles for export—copra, coconut oil and desiccated coconut.

PRESENT METHODS OF CULTIVATION.

The best lands available for coconut cultivation in Ceylon are those with alluvial deposits along the lower courses of the rivers. Next, the most important soil-types are the very sandy loams which are to be found especially along the coast low lands. More towards the inland are to be found mostly chocolate-coloured loamy soils interspersed with tracts having cabook, a product of disintegrated gneiss.

It might generally be stated that a soil with such physical consistency as would give it the best chance of increasing its property of porosity is the one that is best suited to the planting of coconuts; most of the soils are chemically poor and require intensive application of fertilisers and manures in order to make them produce a good harvest.

Since the cultural methods adopted are naturally largely governed by the type of land on which the plantation is laid out, a detailed description of the cultivation would entail careful accounts of such methods as are adopted on each and every one of these different types of land. Such a task would make us deviate too far and so we shall only make reference to literature already existing on the subject.† But we give here some notes of observations in this regard made during our stay in the coconut growing districts. This will enable the reader to form an idea of the stage of development that the coconut industry in Ceylon has reached.

One should bear in mind that there is a distinct difference between the mixed gardens and primitive plantations of small owners and the great coconut estates. We shall first say something regarding the cultivation of the former.

Generally very little care is given to these plantations. When the whole close cluster of coconut palms is considered too old for production the owner starts substituting them by degrees and at leisure. Two or three yards away from an already existing tree he plants the young plant that is to replace the old one; then, by degrees, in a few years, he cuts down the plants that are deemed unfit.

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* The preparation of this alcoholic beverage has been carried on in Ceylon to such an extent that the Colony derives from licenses granted to distil it an annual revenue of Rs 9,000,000.

† Vide: FERGUSON, J, *All about the Coconut Palm*, Colombo, 1907, 4th ed. Notes of A. E. RAJAPAKSE in the *Year Book* 1919-20 of the Ceylon Agric. Soc. The Chapter on Coconut Cultivation in Ceylon in Hamel Smith & Pape, Coconuts, the Consols of the East. London, 1912; Pratt, D.S. The Coconut and its Products, with special Reference to Ceylon. *Philippine Journal of Science*, Section A. Vol. IX, p. 197, (1914).

Not much attention is paid even to the nurseries. These are generally laid out in the shade engendered by a thickly planted part of the plantation. The surface of the ground is tilled up and the seed-nuts, mostly with the opening where the germinating sprout appears turned upwards, are buried in the loose sand to a certain depth allowing the top part of the husk to be visible. The nursery is fenced off in order to protect the young plants from the attacks of straying cattle. The young plants remain very long in the nurseries, often until the first leaves reach a length of from two to three yards. Then they are taken over to their permanent positions on the plantation and put into pits two or three feet deep. Again a railing is erected around these pits in order to prevent the leaves being eaten up by cattle that are kept on the land. A characteristic of such plantation is the want of sufficient spacing between the trees, and all along the sea coast, on account of this defect, they present rather an abnormal appearance. We clearly notice the slanting positions of most of the trees. This slanting growth towards the open is also a common characteristic of coastal plantations. It is not at all unusual to find on these plantations so many as 200 trees to the acre, which leaves but the small distance of 15 feet between the plants. It is quite certain that such close planting is certainly not conducive to the benefit of the total produce; but the Sinhalese planter owning a small piece of coconut land does not seem to have profited much from long adherence to this method of culture. It should not however be forgotten that close planting has this advantage: it protects the trees from being harmed by the strong winds that the plantations along the coast have to withstand during the stormy South-west Monsoon.

Typical of the native plantations is the binding of one or two dried coconut leaves round the trunk of the tree at a height of about three or four yards from the ground. The rustling which accompanies the removal of these leaves from the trunk for climbing is very helpful in overcoming coconut thefts at night. * Another curious thing that might be noticed is the custom of the people to depict with tar on the stems of the coconut tree figures of snakes. According to the belief held by some Sinhalese villagers those figures on the trees frighten away the rats.

Manuring on the plantations of these villagers is more often only the exception. On the other hand in the first few years intercalary crops of food-stuffs are regularly raised on the land which is thereby deprived of a good quantity of plant food which would otherwise go to nourish the coconut palms.

Mechanical cultivation too is less often the rule than the exception. In the latter years, owing to the presence of cattle on the plantation, no weeding is carried on, and close planting too does not generally cause a heavy crop of weeds to grow.

The tapping of the newly opened flower spathe for obtaining toddy from which arrack is distilled is commonly resorted to all through the Island by the villagers. A tree is tapped for a year or for two years in succession and then it is given a period of rest during which time the nuts are allowed to develop as usual. It has not been ascertained to any degree of certainty how far tapping is prejudicial to the capacity of the tree for

* The same custom is noticed in Java too, but there it is much less common.

bearing later. The people of the place nearly all agree that in the first year after the tapping has ceased a very plentiful crop is gathered, but the endosperms of the nuts of these crops are less developed than those of the nuts of untapped trees, and the amount of copra manufactured from such nuts is abnormally small.

Once every two months the owner or a special plucker climbs every tree and picks every matured nut on it. As a normal producing palm puts forth a new flower spathe every month it follows that at every bi-monthly plucking the nuts developed from two flowerings are plucked, and there is some difference in the stage of maturity between the nuts of the two blooms. The villager does not however show much anxiety to let his nuts reach a perfect stage of maturity before plucking them.

Although it cannot be laid down as certain, it is however very probable that the largest number of nuts is gathered during the period of between ten to twelve months after the time the flower from which they developed opened. The nuts are never allowed to remain on the tree to become so ripe as to fall of themselves. In plucking, the pluckers are never guided by such outward characteristics of the husk as its stage of desiccation or its shade of colour. On the other hand the outward colour of all the coconuts that we saw being plucked in these parts of the Island was green uniformly and the cross-section of the husk showed, in addition to the fibre, a white mass of compact pith. The stage of maturity of the fruit is then obviously of importance when the husk is to be utilised for the manufacture of fibre.

Agricultural authorities in Ceylon strongly deprecate the making of notches and incisions on the bark for the purposes of climbing the tree in the method employed in Java. All wounds on the bark of the trees give favourable opportunities to infection from the stem bleeding disease. It is to control this disease which is wide spread in Ceylon that the wounding of trees is so much guarded against. The interesting research of PETCH* shows that a fungus, *Thielaviopsis ethacetieus* WENT, must be considered the cause of this disease. The fungus was first discovered by WENT as being a parasite of the sugar-cane in Java, causing the 'Pine-apple disease.' In Java, however, in spite of the method generally adopted of cutting horizontal incisions on the bark of the tree in order to help the climber, the bleeding disease has not established itself in so pronounced a manner.

It is of course a well known fact that as a rule those in charge of the large coconut estates in Ceylon pay much more attention to proper cultivation than those who own or look after the gardens or plantations in the Southern and Western Provinces. But even on the estates proper the cultivation of coconuts is not intensively carried out. From the best method of cultivation adopted on the large estates proper there are to be found plantations and gardens in every imaginable stage of culture, deteriorating in transition till the mode of extensive culture adopted by the villagers is reached.

In the large estates that are under English supervision the affairs are carried on nearly as described below.

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* T. PETCH. The Stem Bleeding Disease of the Coconut. *Circulars and Agric. Journ. of the Royal Botanic Gardens, Ceylon,* Vol. IV, No. 22, 1919.

In the first place much care is given to the selection of the seed-nuts. Generally a number of trees that are from 20 to 40 years old and bear well are selected. It is from these that the seed-nuts are taken; generally the nuts that are round-shaped are preferred as such nuts are regarded best suited for the production of copra. When the fruits selected are quite ripe they are plucked and, before they are brought and laid out on their nursery beds, they are allowed to dry on the ground for two or three weeks.

MR. A. E. RAJAPAKSE, the well-known authority on coconuts, is a great advocate of the method of planting coconuts in the nurseries in a vertical position, with the opening for germination upwards. This method was also strongly defended by VAN DER WOLK.* However there is very little agreement among the coconut planters in Ceylon on this point, and the method of laying the seed-nuts horizontally has as many supporters as the other.

The ground to be planted is cleared and the vegetation that was cut down is burnt on the land. On most soils the usual distance between the plants is 25 feet in every direction; on very fertile ground however the distance of 27 feet is preferred. This allows the raising of 70 and 60 trees respectively on an acre.

The plant-holes are made 3 feet by 3 feet and 2½ feet deep. Before placing the plants in the holes it is advisable to strew the bottom with a mixture of ash and top soil. Immediately before planting, this mixture should be moistened whilst on dry ground just before planting.

The beginning of the rains is the time preferably chosen for planting out, but it is not always necessary to wait for this time as the plant can live a long time drawing upon its reserve food in the nut. The stage at which a young plant is best suited to be transplanted from the nursery is when the fourth leaf begins to unfold. Sometimes in the first year a catch crop of cassava is obtained from the land, but, generally, after this, some kind of green manure, mostly the Crotalaria varieties, are sown. These green manures are at regular intervals cut up and ploughed into the ground. Clean weeding is very seldom resorted to but the ground around each tree within a circle of 6 feet radius is regularly cleared of all vegetation twice a year, generally after the rainy season has passed. Attached to the estate there are almost always in the older plantations a number of cows, and to provide for their sustenance the owners gladly allow the grass to grow. The ground is however ploughed once a year regularly, or in the case of ground consisting largely of cabook (disintegrated gneiss), the soil is turned up with a fork. Iron ploughs are used and these are drawn by oxen. Generally the plough is not brought closer than a distance of three yards from the tree, but in some cases the tree is approached very close. The aim of the latter mode of ploughing the land close to the trees is to force the tree to form new roots that would direct their courses deeper into the ground and make the tree better adapted to withstand unfavourable meteorological conditions.

The land is terraced when plantations are laid on sloping ground. Blind trenches are also dug for catching up the soil that is washed off.

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* VAN DER WOLK. *The Rise, and the Employment of new methods in, Coconut Cultivation, Cultura p. 165 (1919).*

These trenches are emptied once a year and the collected silt is spread over the plantation. In recent years much importance has been attached to the returning of all vegetable matter of the plantation to the soil, not as ash after burning, but in its organic state. In this way the capacity of the ground for absorbing moisture is considerably augmented; and in view of the great supply of water the coconut tree demands of the soil, this is, in many cases, a consideration of great importance.

Having in view the same aim—that of preventing excessive loss of moisture—combined with the purpose of keeping away cattle, young coconut plants are surrounded by a ring of heaped coconut husks 4 meters in diameter and one metre high. On some plantations even the older trees are surrounded by a similar ring of single husks.

The need for manuring coconuts is generally felt in Ceylon especially in the plantations where the husks are used for making fibre. By this the soil regularly loses a great quantity of the organic material that would make good plant food.

On some estates however, the coconut waste that is left in great quantities when the fibre is threshed out is brought back and ploughed into the land. The cost of transport of this bulky material is a great obstacle in the way of this good practice. Therefore the practice of resorting to chemical ferilisers is generally adopted.* Next to these manures the use of cattle manure is profitable and this is seldom or never wanting. Generally the cattle tied two together are allowed to roam about the plantation; but for more intensive manuring of weak trees an animal is tethered for a week to the tree that is to be manured. Other articles used as manures are poonac, bone meal and ash, and sometimes slaked lime too. The methods in which these different substances are administered are very varied. The following is a suitable method: Trenches 1½ feet wide and 5 inches deep are dug around a full-grown tree and the manure is placed in them. The radius of these circular trenches is in the first year 3 feet, in the second 5 feet, in the third 7 feet, in the fourth 3 feet, and so on. Another method is to till up the ground with the radius of 1½ metres from the tree and work the manure in. The ground thus worked should be entirely free from weeds. In strong contrast to these methods, in some estates in the middle of an open patch of ground between four trees a hole 4 by 4 metres and 15 centimetres deep is dug and the manure is put in to it. The amounts of manure used also vary considerably.

For full-grown trees MR. A. E. RAJAPAKSE recommends 4 lb. steamed bone meal, 10 lb. ash and 14 lb. bean cake.

The harvesting takes place generally every two months. A climber can in one day pick but 400 nuts whilst an experienced plucker who uses a tall bamboo with a sharp knife at one edge can harvest on an average 3,000 nuts. The harvesting of coconuts in the latter way requires pluckers with some dexterity and it is not without danger to the pluckers.

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*Particulars regarding the manuring of coconuts in Ceylon are found in the following: M. KELWAY BAMBER, *Coconuts: Experiments at Peradeniya, 1912.* M. KELWAY BAMBER, *Coconuts: Experiments at Peradeniya, 1914.* Buls. Nos. 2 and 10 respectively—Dept. of Agric., Ceylon; *Manning Coconut Trial Ground*, Rept. 1914--18 by A. E. RAJAPAKSE, Negombo.

The plucking is done mainly by Tamil coolies who belong to one special caste. All the work of plucking, gathering, carting and transport to the copra shed is done on contract, the cost for the whole year amounting to Rs. 2 per acre. Tamil women with a handy spear which they drive into the husk collect the picked nuts and heap them. The bi-monthly plucking of nuts has a disadvantage: the stage of the ripeness varies, as nearly half the nuts attain a higher maturity from being a month longer than the others on the trees. The disadvantage of the bi-monthly harvest is acknowledged, but the extra expense incurred in plucking every month will not be covered by the results of the advantage gained from it. In the estates the nuts picked are undoubtedly riper than those picked in the Southern and Western Provinces, but the nuts are never allowed to remain till they get that buff colour which is an indication of the drying of the husk. For this reason instead of (as is done in Java) utilising the nuts at once, they are heaped up and covered with a few coconut leaves. This seasoning process is a step that is never omitted in the case of nuts for the manufacture of good copra. This is done in order to ensure a fairly even state of ripeness in the fruits, and if it were not done the drying of the kernel presents more difficulty and the copra is not very firm. We shall not here dwell on copra preparation. The people prefer to prepare sun-dried copra, although a good quality of it is also dried on simple grills heated over a light fire kindled with dry coconut shells. If this operation is carefully carried out a very good quality of copra which traders do not differentiate from sun-dried copra is obtained. This is remarkable in view of the fact that Ceylon copra has so good a reputation in the World market.

THE DRYING OF COPRA.

The main cause of bad colour and acidity in copra is ascribed to the action of moulds, and it is therefore essential that copra should be well dried. In the case of large plantations the most economical method of drying is by means of steam, using modern machinery, but on small plantations this method is not profitable owing to the comparatively high initial cost and over-head expenses of steam-driers. The problem of copra drying on small plantations has engaged the attention of the Bureau of Science of the Philippine Islands, who have found that sun-drying after exposure to the fumes of burning sulphur gives satisfactory results. This procees has been in operation for several years, and an article in a recent number of the PHILIPPINE JOURNAL OF SCIENCE (1922, 21, 49) records certain modifications that have been found advisable. Details are given of the construction of the chamber in which the copra is treated with the fumes of burning sulphur. This chamber is built to hold 3,000 nuts at one charge, and for this quantity one kilogram of sulphur is required and the process lasts about four hours. Although the nuts may be sulphured before the removal of the shells, it is recommended that they should be submitted to a preliminary drying in the sun whereby the kernels are loosened from the shells. The kernels are then separated from the shells by a knife and transferred to the sulphur chamber. After this treatment the product may be dried in a shed, should the weather be unfavourable for its being spread out in the sun. The final copra is generally lighter in colour than the whitish ordinary sun-dried product, and contains about 5 per cent. of moisture and 1 per cent. of free fatty acids.—INDIAN SCI. AGRIC., Vol. 4. No. 12.

CACAO.

THE YIELD OF BUDDED CACAO.

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For the last thirty years or more it has been known that the cacao tree is capable of being reproduced vegetatively by means of budding or grafting, though up to the present the area of budded cacao under cultivation remains infinitesimal. The part played by vegetative propagation in the distribution of desirable types of fruit trees is perhaps shown to greatest advantage in temperate climates where apples, pears, cherries, &c., are always grown as "clonal"* varieties under separate and distinct names. Even in the tropics, however, vegetative propagation of good types of mango, avocado, citrus fruits, &c., is carried out to an enormous extent, and probably if cacao had been directly edible a considerable number of clonal types would have arisen, for few plants show more diversity in character of fruit and seed than cacao.

It should be borne in mind that direct breeding for yield plays little part in orchard fruits of the temperate zone, probably because wherever a desirable type of apple arose from a chance seed, say the Ribston Pippin, it was propagated vegetatively without undue regard for its bearing qualities. Thus some varieties of apples and pears are notoriously "shy bearers".

In cacao the main problem before us is to produce fields of uniformly high productivity, while maintaining or improving quality, and so far, in various parts of the world, two lines of approach have been opened up, which consist in propagating from high bearing trees (*a*) by budding or grafting, (*b*) by seeds. It is the object of this paper to discuss the significance of some results from budded and grafted cacao obtained by the Trinidad Department of Agriculture at River Estate.

The Experiments: Yield of the Parent Trees.—Since 1910, the yearly return of pods from a large number of trees has been recorded individually at River Estate and it was quickly noticed that certain trees were good-bearing—producing a hundred or more pods annually, while others were just as consistently poor in yield. It was felt that seedlings from superior trees were likely to give better progeny than seedlings from unselected trees, and it has been the practice of the Department for some years to offer for sale seedlings only from superior trees. It was considered likely also that budding from superior trees offered a means of producing uniformly high yielding areas, and many budded cacao trees have been distributed. Experiments were carried out in 1914 in which 28 superior trees were

* A "clone" is a family of vegetatively-produced progeny, the scions of which are derived from a single parent.

propagated both vegetatively and by seeds as indicated in the following table:—

No. of Plot.	*Mode of Propagation.*	*Total in trees*	*No. of trees from each parent*	*No. of parents.*
A	Budded at stake, no shade	280	10	28
B	Budded in nursery, with shade	280	10	28
C	Seedlings with shade grafted	280	10	28
D	With shade	280	10	28
E	Budded at stake, no shade	280	10	28

Each of the five plots is laid out similarly, the progeny of each parent (10 trees) either vegetative or seminal occupying a similar position in each plot. There are thus 40 budded and grafted trees in 4 plots, and 20 seedlings in 2 plots, from each of the selected parents. Fruiting began in 1917-18 in both budded and seedling trees and the number of pods produced by each of the 1,400 trees has been recorded for 6 years. Within the compass of this short preliminary paper it is impossible to set forth the full results. *

The following are the chief points of importance :

(1) The total number of pods borne by the different sets of 40 trees from 1917-23 varies from 261 (set 1229) to 2278 (1114).

(2) Tree 1229 which gave rise to the bad set of budded offspring, has yielded 2,307 pods since 1910 being 5th on the list of heavy bearers, while tree 1114, which has yielded only 1,380 pods since 1910, is 21st on the list of heavy bearers, but is decidedly the best mother tree of the 28.

(3) There is no correlation between the yield of the parent and the mean yield of its budded offspring, *i.e.*, between a mean yield of 79 pods per annum and 220 pods per annum there is no tendency for the higher yielding trees to produce higher yielding progeny. This leads to the further conclusion :—The yield of a tree affords no criterion whatever of the sort of budded offspring it will produce and the value of a tree for budding purposes must be assessed in terms of the mean yield of its budded offspring.

(4) Certain trees are demonstrably good mother plants and are able to transmit yield to their vegetative offspring. Thus Nos. 1114, 1139, 1454, and 2359 may be picked out as worthy of propagation, while Nos. 1229, 2453, 1285, 407, 2314 and others whose clones have produced less than 1,000 pods per 40 trees in the 6 years are so bad that it would be unwise to propagate from them.

(5) Some slight variation in the order of merit of the clones may result from further records of yield during the next 10 years but this will probably not affect the recommendations in paragraph 4.

Significance of the results.—The comment may be made that variability of soil and growth conditions is so large in the plots as to render invalid for

* The full statistical data are available for reference at the *Imperial College of Tropical Agriculture*, and they will probably be incorporated later in a special memoir. The present writer is indebted to the *Trinidad Department of Agriculture* for permission to use the results of their experiments for interpretation.

the purpose of analysis any data on the yield of the various clones. Examination of the yield of the extremely bad clone 1229 in relation to the yield of the adjacent clones, however, shows that its low yield is not due to environment but is inherent. This is shown by the following method of analysis. A block of 9 clones is taken with the 10 trees of 1229 in the middle. The mean yield of the clones is taken and the yield of each clone is taken as a percentage of that mean yield. The following results are then obtained :—

Parent.	1114	1278	1386
Yield as % of mean	175	69	72
	204	136	34
	208	127	127
	195	37	99
Parent.	1097	1229	1333
Yield as % of mean	64	28	72
	78	10	70
	85	24	60
	160	21	66
Parent.	969	1158	1304
Yield as % of mean	155	101	161
	140	54	174
	43	96	132
	135	110	77

It will be seen that the yield of 1229 varies from 10 to 28 per cent. of the mean of the block of 9 in which it occupies the middle, whereas the yield of 1114—the highest clone varies from 175 to 208 per cent. of the same mean. It could be shown statistically that 1229 is significantly lower than any of its neighbours in all of the 4 plots, but such an analysis would not be more convincing than that already made. Taking clone 1114 as the middle of another block of 9 we obtain the following results:—

The yield of the 4 groups of plants of clone of 1114 vary from 178-215 per cent. of the mean yield of the block of 9 of which they occupy the middle position, while the yield of clone 1229 similarly varies from 10 to 23 per cent.

The point may then be regarded as proved—that certain trees, high bearing in themselves, produce budded offspring of low yielding capacity which is inherent and not due to environmental conditions.

Discussion.—In undertaking an enquiry whether the yield of cacao will maintain itself in vegetative progeny from a high-bearing tree, it is necessary first to get some idea of how the yield of a cacao tree is built up. Fruits come from flowers, and flowers come from buds, so that if the number of buds on a tree were very small, the number of fruits could not exceed this number and the yield would be low. In actual fact, however, the yield of a cacao tree is never limited by the number of flowers produced : often indeed trees bear enormous number of flowers which fail to develop into fruits, but drop off one or two days after opening. The number of flowers,

therefore has very little to do with the actual crop produced by the tree, which is built up in the following stages. A certain number of flowers is produced by the tree, of which the vast majority, about 90 per cent. or more, fail to get pollen and drop off the tree unfertilised. Of those which get fertilised only a few per cent. actually form pods, and of those which succeed in setting pods only a certain number reach the mature stage. Some are attacked by pod rot (Phytophthora), while others dry up when partially mature for reasons which have not yet been worked out but are presumably connected with soil and weather conditions.

It is clear that the yield of a tree is the end point of a long and complicated series of reactions between the constitution of the tree, *i.e.*, its hereditary make-up, and the environmental conditions in which it is placed. The critical stage in the building up of yield seems to be that of fertilization, and observations on the setting of fruit on productive and unproductive trees by R. PARGA and the writer at this College indicate that while a productive tree can be induced to set a great many young pods by artificially fertilising the flowers, it is impossible to make an unproductive tree set fruit, however great the number of flowers pollinated. The cause of high yield in cacao is thus primarily physiological; a tree is either a "good setter" or a "bad setter." If a tree is constitutionally a bad setter it does not matter what environment it is placed in, or how rich the soil, it will never produce a large crop, while if a tree be a good setter it will produce a bad crop under bad soil or climatic conditions but is, on the other hand, capable of bringing a large number of pods to maturity under good conditions. It is this type of tree which will respond to good cultural and manurial treatment.

Having thus preliminarily discussed the conditions which favour productivity in cacao, it is possible to analyse the possible effect of vegetative reproduction on each of the main stages of yield-building. This can only be done in a general kind of way, and often only from analogy with other plants. When a bud is removed from a high yielding tree and placed on another stock the environmental conditions are absolutely altered. Every stock is planted in a different kind of soil, and probably no two trees are alike in hereditary constitution, since it is an observed fact that in the progeny of a single tree no two trees are alike. For example in the third generation from a selected tree segregation in respect of at least five Mendelian factors has been observed, which means that there are 32 different possible pure types, besides the impure types which may differ in appearance from those which are pure.

Next must be considered the effect on the setting of fruit of putting a bud from a good setter on to another stock. It would be unwise to conclude that the stock will have no influence on the physiology of this process. Indeed it is most likely that the type of stock will prove a most important factor in this connection, and the ultimate yield of a budded tree may be pictured as a result of the interaction of the setting capacity of the stock, and that of the scion.

The writer is inclined to regard the physiological condition of the stock and the type of root system which it produces, as the predominating

influence in the setting of fruit, and it is just as possible that a good bearing tree can be produced by taking buds from a bad setter and placing them on good setting stocks as by taking buds from good setters and placing on stocks the setting capacity of which is not known.

Some experiments carried out by the writer on the yield of budded cotton plants are of interest in showing the effect of budding on the shedding of young fruits. Sea Island which is rather liable to shed its young fruits was budded on to a West Indian perennial stock. The tendency to shed was much reduced in the budded plants. When Sea Island was used as stock, and West Indian as scion, no fruits whatever were set, though the plant produced several hundred flowers. Though there is no close analogy between shedding in cotton, and shedding in cacao, it is significant that in one plant at least, change of stock may reduce the yield to zero.

Observations on the yield of budded rubber, and of grafted apples show also that the stock cannot be ignored as a factor in the yield of vegetatively propagated plants.

It has indeed been shown by SAX and GOWEN that the same tendency to wide and permanent variation in yield from tree to tree exist in *grafted* apple trees, and further can be explained by a combination of factors the most important of which are soil and type of root stock. They point out that "since root stocks grown from seed are often extremely variable and may often be weak and dwarfed, it is not surprising that clonal varieties grafted on such stock vary greatly in growth and productivity. The presence of many unproductive trees in our orchard may be attributed in part, at least, to the effect of weak or incompatible root stock."

The results obtained by bud-grafting rubber in the East are of a similar nature to those obtained with cacao in Trinidad. An investigation was made by PINCHING of the whole status of budding rubber and his views may be stated.

(1.) "No evidence could be found existing in the Dutch East Indies proving the unqualified success of bud-grafting as a certain means of raising high-yielding trees.

(2.) "A marked similarity in yield (as compared with seed-produced trees), of trees of one clone is indicated by the results of tapping bud-grafted trees. Further, some high-yielding mother trees appear always to give high and above average yielding vegetative off-spring. *At the present time there appears to be no connection, however, between the yields of mother trees and their vegetative off-spring.*"

Further results from budding rubber in Java have recently been published by HEUSSER. He concludes that there are mother trees whose vegetative offspring are invariably unsatisfactory although they are themselves high-yielding, and states that "the quality of a mother tree for budding purposes can only be detetmined with security from the tapping results of its buddings". HEUSSER is of opinion that the vegetative propagation of rubber must be considered as a temporary measure until seed selection becomes sufficiently advanced to provide heavy bearing strains which come true, and possibly the same opinion may come to be held with regard to cacao.—TROPICAL AGRICULTURE, Vol. 1 No. 5.

THE QUALITIES IN CACAO DESIRED BY MANUFACTURERS.

Many growers of cacao would be glad to know what qualities in cacao are considered desirable by manufacturers of cocoa and chocolate. Unfortunately it is by no means possible to make a definite statement which is generally applicable, because the various manufacturers look for different qualities, and cacaos from certain districts are prized for special purposes. There is, further, some danger in describing a desirable appearance, for it is not the appearance that is wanted, but the qualities that are associated with it. In general, we believe that if the planter only allows ripe pods to be gathered, ferments for a reasonable period, cures with care, and keeps the beans dry, they will have the right appearance to satisfy the manufacturers, and he will be producing the best that the type of tree on his plantation will produce. In many places the individual who does better work than his fellow-planter does not directly reap his reward in higher prices. This is to be regretted. Indeed, we have been told by planters that it does not pay to take more than a certain amount of trouble in fermenting and curing their cacao, as they obtain the same price any way, but if all planters worked down to the minimum quality, the price obtained for beans from that district would fall, and all would suffer. At present, the planter who produces above the average is a benefactor to his fellow-planters and he who produces below the average quality lowers the price of the whole production of that district.

Any district or country which could establish and successfully maintain a standard which prohibited the presence of unfermented, diseased, germinated, or grubby beans, and which fixed a maximum percentage for rubbish and shrivelled beans, and could at the same time put on the market large consignments of such beans, suitably marked, would be sure of establishing a reputation in the London and Liverpool markets, and as a result obtain high prices.

Unripe Cacao.—In gathering the pods, the planter should take care that only the ripe ones are picked. The planting of a single variety on a plantation would greatly facilitate this.

If the pods are gathered before they are ripe, a poor yield is obtained and the cacao is of low quality—the beans being small, flat and tough, with a whitish break. And further, the shell is very difficult to remove. Unripe beans do not undergo the normal fermentation. In an experiment on MESSRS. CADBURY'S estate in Trinidad unripe pods were purposely picked. In fermenting, the temperature never rose above 95° F. (*i.e.* 15° F. below the temperature of a heap of the same size of ripe beans), and the beans appeared gummy and slimy. With ripe cacao the average yield of dry cured cacao is about 36 per cent. of the wet cacao put in the sweat-box. With this unripe cacao the yield was only half that usually obtained.

Over-ripe Cacao.—It must naturally happen on estates which have insufficient labour that the pods are often left on the tree after they have become ripe. As an experiment, pods were allowed to stay on the tree six weeks after they were ripe. When placed in the sweat-box the beans

rapidly started to ferment, and after 24 hours were at least 10° F. warmer than the normal. After this the temperature was normal. The beans produced were large and plump, but the shells were crisp and fragile. When roasted the product was inferior to ordinary cacao. The friability of the shell is also an objection to over-ripe cacao. The danger with over-ripe pods is that the beans may have commenced to germinate. One objectionable result of this is that when they are dried the germ frequently produces a hole in the shell, which opens a way for attack by mould and grubs.

Germinated Beans.—Beans which have germinated (whether by being left in the pods till very much over-ripe or scattered on the ground by squirrels that have attacked the pods) give on roasting an inferior product, with a slightly herbal odour and an astringent taste. The presence of even a small percentage of germinated beans exercises a deteriorating effect on the quality of any goods in which such cacao is used, and hence we regard the presence of germinated beans as objectionable.

Unfermented Cacao.—Unfermented cacao readily finds purchasers but fermented cacao always obtains a higher price (usually several shillings per cwt. more than the unfermented). The reason for this is that unfermented beans produce a cocoa inferior in colour, odour, and flavour. Partially fermented beans suffer from the same defects. On some plantations one day's picking is put on the top of the previous day's picking, and uneven fermentation is the result. In some cacaos one finds "cobs" (two or more beans stuck together); their presence is regarded as an indication of careless preparation, and certainly such beans cannot be properly fermented. We think there is usually little danger of *over-fermentation*, but where this occurs the shell may get so loose that it becomes broken in carriage and handling.

In particular we would point out that cacao can be spoiled by lack of attention to conditions of cleanliness during fermentation, or by exposing to bad odours. On curing these defects may be hidden only to be revealed again on roasting, when the objectionable "hammy" or other flavour is developed.

Fermentation.—New Methods.—Whilst at present we are very well satisfied with the standard methods of fermentation practised in the tropics, we look forward in the future to interesting developments. But as yet we are not prepared to recommend any radical changes. For example, the very interesting method of removing the pulp put forward by M. PERROT, which consists of treatment with alkali, does not appear very promising from the economical standpoint. It is clear that such methods would not decrease the cost of production in the country of origin, and the manufacturer would have the extra expense of treating such cacao before roasting. Further, considering that on the vast majority of plantations several botanical varieties of cacao grow up side by side and that these are never sorted according to their kind, there is very little prospect of a uniform product such as manufacturers desire—and M. PERROT promises.

Washing.—After fermenting it is usual in some countries to remove the pulp by washing. This process slightly reduces the weight and improves the appearance of the bean. It has the disadvantage, however, that it leav

the shell thin and breakable, and renders the cacao more liable to attack by grubs ; it is also probable that when such cacao is placed along with other cargo having a strong smell, it more easily takes up such flavours than the unwashed cacao.

On the whole we recommend that (save in those countries where washing is considered essential to satisfactory sun-drying) the beans be not washed. The planter obtains a bigger yield, which fetches in England practically the same price per cwt., because the unwashed product is considered to have better keeping properties. The loss in washing amounted to 8 to 10 per cent. without adding to the price realized by the product.

Drying.—It is essential that beans should be thoroughly dry before being bagged. Care must be taken not to over-heat the cacao or to break the shells. In some countries the climate necessitates *artificial drying.* But in some places where the sun's heat can be used, it is always to be preferred, because there is a tendency with the use of artificial heat to speed up the drying process, and our opinion is that such rapidly-dried beans are not so well cured as those dried slowly in the sun.

Cleaning—From a manufacturer's point of view, the freer the beans are from dried placenta, flat beans and rubbish, the better. In 1914 the planters on a certain West Indian Island sent so large a percentage of shrivelled beans and waste to New York that there seemed some risk of the American market being closed against them. Happily, they have mended their ways, and are now delivering cacao satisfying contracts in which the waste must not exceed ½ per cent.

Claying.—Claying makes beans look pretty ; it is said to assist materially in the drying, and it is generally held that the film of clay protects the beans from attacks of mould, and also strengthens the shell for handling. Personally, we question the last two advantages, and would point out that from the manufacturer's point of view claying increases the cost of production, and that the buyer pays for cacao and obtains clay. However, we do not think that objection would have been raised to claying if the process had not been abused in recent years. One abuse is using above 1 per cent. of clay.

A more serious abuse is the taking of black cacao from diseased pods and claying this so as to give it the appearance of good estate cacao. This use of claying is sufficient to condemn the practice from the manufacturer's point of view, more particularly if merchants mix this diseased cacao of deceitful appearance with fine cacao.

Dancing and Polishing.—Where dancing is employed, not as a method of breaking apart those beans which are stuck together, but simply as a method of applying clay and producing a polish, it has little to recommend it. Dancing improves the appearance of the beans and gives them a very pleasant gloss, but from a manufacturer's point of view we have no evidence that this process is of any advantage. We consider that 2*d.* per cwt. spent on this is wasted.

There are mechanical polishers which give the beans a bright and uniform appearance. Such beans fetch a slightly higher price, but manufacturers will in future value beans more and more on their internal qualities alone.

Size.—Large beans are preferred because they have a lower percentage of shell than small beans, and cacao carefully graded to size is more appreciated because it affords greater facility for uniform roasting.

Flat Beans.—Manufacturers object to flat beans because :—

(1) Flat beans shell less easily. In the rounder bean the shells are more free.

(2) Flat beans have a greater percentage of shell.

(3) Flat beans do not roast so evenly.

(4) Flat beans are generally evidence of unripeness, insufficient fermentation or careless drying. Good curing of ripe cacao produces a round bean, and, as is well known, Criollo give the roundest or boldest, and Calabacillo the flattest bean.

Grubby Beans.—Cacao sometimes arrives in England much eaten by grubs. The cacao moths should be kept away from the beans during drying as much as possible. They deposit their eggs on the beans, and the grubs which hatch out eat their way into the beans with broken shells. The trouble does not always end here, as the moths may migrate in the stores to other bags of cacao. Beans with the minimum of broken shells best withstand their attacks.

Aroma and Break.—The beans should have a clean, pleasant, faintly acid odour ; the presence of the slightest foreign odour is objectionable.

Beans should break readily into small crisp nibs. Any show of hardness or cheesiness lowers their value.

Constancy of Quality.—Probably the most highly appreciated character is constancy or reliability of quality. Cacao which varies from bag to bag or from time to time will get little appreciation. Under ideal conditions standard qualities would be put on the market—Criollo, Forastero and Calabacillo would be fermented separately and the beans graded according to size. Such a procedure would only be practicable where the cacao from several plantations was taken to a central fermentary. At the present time we are far from this : indeed, instead of a careful grading of good qualities there is in practice a mixing of good and bad. We have good reason to believe that some merchants buy cacao which they know to be diseased or unfermented or mouldy, and deliberately mix it with good cacao. Such an action may not seriously affect the price of that particular lot, but it affects detrimentally the reputation of the cacao from that district, and the manufacturer comes to regard it as less desirable.

It is sometimes stated that cacao is valued largely according to its geographical origin, but we would point out that this value is the resultant of the value of the type of bean grown in that district and the amount of care given to the curing—thus a reputation is established for that district. It is also sometimes contended that the value of cacao depends almost entirely on its botanical variety. It is the old problem of heredity and environment. Criollo obtains a higher price than Forastero and Calabacillo because it is the rarest. But the planter's problem in most parts of the world is how to produce the best cacao from the mixed breed which his plantation produces. This is done by providing a suitable environment, *i.e.*, keeping the trees under healthy conditions and curing the cacao with the greatest care.

It should be pointed out that the manufacturer does not make final judgment of the bean in its raw state. It is only when it is roasted that he is able to determine its exact value for his purpose.—JOUR. OF THE JAMAICA AGRIC. SOC., Vol. XXVIII, Nos. 2 and 3.

FRUITS.

CITRUS CULTIVATION.

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HISTORICAL.

Citrus fruits are first recorded as occurring in the Malay Archipelago and Southern Asia. Though undoubtedly of tropical origin, it is in the semi-tropics that their development has reached the highest point and where they have been the greatest success commercially.

As compared with such fruits as the olive, date and fig, Citrus are of modern origin. No mention is made of the sweet orange until its introduction into Southern Europe from South China by the Portuguese in the fifteenth century. The sour orange originated in India and it was introduced during the tenth century by the Arabs into Sicily and later it was taken to Spain and the New World. The citron, or apple of the Persians, was introduced by the Romans in the third century to Italy. The first reference to the lemon is by the Italians in the twelfth century.

CLASSIFICATION.

Citrus belong to the family *Rutaceae*. No species of the genus is indigenous to the New World. The only relative occurring in the New World is the prickly ash, *Xanthoxylum americanum*, in the south-eastern United States.

The species grown in this island are—

Citrus sinensis—sweet orange, including the Washington Navel, Valencia, Mediterranean, etc.

Washington Navel.—Fruit rounded, longer than wide, slightly tapering towards apex ; skin, smooth to pebbly, from $\frac{1}{8}$ to $\frac{1}{4}$ of an inch in thickness ; very juicy, flavour, excellent ; colour, orange ; seedless, except in a few cases. Tree small, prolific, thornless, except on vigorous shoots. This variety originated in Brazil.

Valencia or "Tardiff," or "Hart's Late."—Fruit oblong, tapering towards the base; colour, pale orange ; skin, usually smooth, thin ; juicy, flavour, slightly acid ; seeds, three to six, sometimes seedless. Tree large, prolific, thorns few. This variety originated in the Azores.

Parson Brown.—Fruit oblong ; colour, pale orange ; skin of a fine texture ; juicy, sweet. Tree, medium sized, prolific. This is an early bearing variety and on this account is a great favourite in the colder citrus sections. It is grown successfully on sour stock.

Mediterranean.—Fruit rounded ; slightly flattened ; colour, deep orange ; skin, smooth ; juicy, very sweet ; seeds, few. Tree small, leaves small ; thornless. This variety originated on the islands of the Mediterranean.

Pine-apple.—Fruit, very variable in shape ; size, medium to large ; juicy, with a distinct pine-apple aroma ; seeds, numerous ; skin, glossy, thin. Tree, vigorous, prolific. This is a popular mid-season variety.

Citrus aurantium—Seville or sour orange.
,, *nobilis*—King orange.
,, ,, var. *delicosae*—tangerine.
,, *decumana*—grapefruit.
,, *medica*—citron.
,, *limonica*—lemon.
,, *aurantifolia*—lime.

GROWTH.

The growth of Citrus trees is not at a uniform rate throughout the year. They produce new foliage three times during the year with intervening periods of rest. The greatest growth is during the spring just before the flowers appear. A less vigorous growth is made in the summer and another in October or November.

The intensity of the growth depends on climatic and soil conditions, as on these factors depends the rate of flow of sap. And here it may be pointed out that there are two distinct sap currents—one current passes through the inner bark from the leaves to the roots conveying plant food to nourish the growing root tips, while the other current passes through the wood upwards from the roots to the leaves conveying dissolved mineral food taken from the water in the soil by the roots. It is in this reciprocity that the number and intensity of the seasonal growth depends.

STRUCTURE.

Foliage.—The variation in the shape and size of the leaves is one means by which the different species of Citrus may be distinguished. For instance, the petiole (wing) of the leaf of the sweet orange is very narrow, of the grapefruit and sour oranges very broad, especially in the case of the leaves on vigorous shoots, and it is altogether absent in the citron. There are other differences in the leaves of the several species, such as, for instance, the character of the margins of leaves ; in the case of the lemon and lime the margins are indented, while those of the orange are entire.

The presence in the leaf of numerous glands containing a volatile, aromatic oil is characteristic of all species of Citrus, the odour of which varies with the species.

All of the species of Citrus grown in Jamaica are evergreen. The heaviest fall of leaves takes place after the season of heaviest growth, that is, late in the Spring.

Thorns.—With the exception of a few varieties, for instance, the Washington Navel, all Citrus trees bear thorns. The sweet orange bears the worse kind of thorns. Thorns are borne in the axils of leaves. They are objectionable not only from the point of view of the discomfort attending the picking of fruit and the pruning of trees having numerous thorns, but thorns damage the fruit if the trees are so situated as to be exposed to high winds.

Flowers.—The flowers are complete, that is, they possess both stamens and pistils. Colour, waxy-white, except in the lemon and citron the petals have a purplish tint; large and fragrant; calyx, green, three-to five-lobed; petals, thick; four to eight in number, covered with oil glands; stamens, numerous; stigma, large; pollen, golden-yellow, abundant.

Lemon trees bear both complete flowers and flowers having merely rudimentary pistils, but only the complete flowers result in fruit.

Fruit.—The fruit consists of a multitude of multicellular juice-containing vesicles enclosed in a more or less thickened skin or rind. The vesicles are attached to the outer wall of the carpel.

Juice.—The juice contains about 0·5% of cane sugar, about 1·5% of other fruit sugars, and from 1·02% of citric acid (Washington Navel orange) to 7·5% (lemon).

Wood.—Colour, light, no difference between that of the heart-wood and sapwood; strong, hard, of a very fine grain.

Roots.—The root system consists of a large main or tap-root and fibrous roots. The tap-root serves to anchor the tree to the ground and to convey food from the fibrous roots to the tree. The tap-root is usually cut off when the young seedlings are being transplanted from the nursery. When such root-pruning is practised on sweet oranges lateral roots are developed, and in the case of sour oranges two or even three lateral roots may be developed.

The fibrous roots are the feeding roots. They are large and very numerous. Unlike the roots of most plants, they do not possess root-hairs. In dry situations and if the soil is deep and well aerated by cultivation, the fibrous roots will penetrate far below the surface layer of soil.

THE GROWING OF CITRUS.

The practice of growing Citrus from seed has been discarded in all countries in which the growing of these fruits is undertaken seriously. Citrus fruits are now budded on stock, which is grown from seed. The kinds of stock which are used on a large scale are in the order of their popularity—the sour or Seville orange, the sweet orange, and the pomelo.

Sour orange stock is favoured in Europe. The sweet orange stock is used to some extent in California. The sour stock has the advantage of being less susceptible to gum diseases and is better suitable for heavy soils. Oranges budded on sweet stock come into bearing somewhat earlier than when budded on sour stock. Pomelo stock is being used successfully in the gravelly soils of the valleys in California, but the seedlings are most susceptible to gum diseases.

THE NURSERY.

The soil selected for the nursery should be a deep rich, well drained, sandy loam. It should be worked into beds having a fine tilth and levelled. The beds should be well soaked with water a day before the seedlings are planted. The seed-beds should be shaded, preferably by one-inch laths one inch apart running north and south and resting on eight-foot uprights. The seeds may be planted by broad-casting, or they may be planted about one inch deep about one inch apart, or pressed into the soil with a plank and covered to a depth of about half an inch with coarse alluvial soil or

sand. The last method is the most satisfactory, as the covering of sand reduces the risk of "damping off" fungi attacking the seedlings and to further reduce the risk of such an attack the minimum amount of water for the requirements of the seedlings should be applied during the first two months and no manure or humus should be used in the preparation of the seed-beds.

In order to reduce the percentage of crooked tap-roots caused by the difficulty of the root in piercing the seed-coat, the seeds should be soaked over-night in water before they are planted.

When the seedlings have passed the age, about two months, when they are susceptible to the "damping off" fungi, they become susceptible to gum diseases, which may be controlled by spraying with Bordeaux mixture. The seedlings may also be attacked by scale insects and the Citrus Black Fly, in the event of which they should be sprayed with a contact insecticide, such as whale oil soap, kerosene emulsion, etc.

The seedlings should become large enough to be used as stock in about a year after planting. Before the seedlings are removed from the seed-beds, the seed-beds should be thoroughly wetted and the soil loosened by means of a spading fork and then the plants may be pulled by hand. Those seedlings having crooked tap-roots should be destroyed. Those seedlings which are to be used for stock should be cut off about eight inches above the collar with a sharp knife or axe.

THE PLANTING OF STOCK.

The soil selected for the stock bed should be a deep, rich loam. The stock should be planted in rows eighteen inches apart and four feet apart in the rows. They should be planted with a spade, care being exercised to ensure that they are not planted at too great a depth and that their roots are set straight. The soil around the roots should be pressed firmly. Since the roots of citrus dry quickly if exposed to the air, resulting in a heavy mortality, only a few plants should be handled at a time and they should be transferred to the stock-bed protected by moss and covered with sacking.

Stocks grown under optimum conditions should be ready for budding in from one to two years, that is, they should measure about three-eighths of an inch in diameter three inches above the collar.

BUDDING.

Propagation by budding is the universal method now adopted since the seedling method has gone out of favour.

Buds should be cut from vigorous round wood, free from thorns, taken from one to two-year old fruiting branches and should be about one foot long and about the size of a pencil in diameter. All leaves should be removed from the bud-wood. Suitable budding-wood is more difficult to obtain in the case of oranges, especially in the navel orange, than in the case of lemons or grape-fruit. To surmount this difficulty in the case of oranges it has been found that pruning a year before the buds are required, orange trees will produce vigorous growth of budding-wood.

Stocks should be budded in October and November and failures re-budded in April or May. The usual method of budding is by making with a sharp budding knife a T-shaped incision for the insertion of the bud in the

bark of the stock about one-half of an inch long at a point about three inches above ground, preferably under a small branch. The bud is cut by inserting the blade of the knife one-half inch below the bud and pulling the blade beneath the bud to a point about one-half inch above the bud. The bud is then inserted in the incision in the stock with the bottom of the bud downwards and pushed down until the upper end of the bud is below the cross cut of the incision in the stock. The bud is kept in position by wrapping a strip of waxed cloth or tape around the stock several times. The wrapping should be removed after about ten days and the buds examined. If the buds have set they will show a border of greyish tissue around the edges. The wrapping should be replaced loosely on the set buds and removed finally in about a month's time.

THE TRAINING OF THE YOUNG BUDDED TREES.

As soon as the buds have started to grow the trees should be tied to stakes with raffia at points about three inches apart under a leaf in order to ensure the young trees having a perfectly straight trunk.

At the same time that the trees are being trained to stakes any side branches should be pruned off and any sprouts originating below the budded stem should be rubbed off. It will be necessary to repeat the latter operation about every three weeks.

The budded trees should be allowed to grow to about three feet tall and then cut back to about two and a half feet. About three to six branches should be allowed to grow out on all sides of the last foot of the stem.

Budded trees grown in a well cultivated and fertilized nursery should be ready for final planting out in the grove in one to two years, so, a period of from four to six years is necessary from the planting of the seeds in the seed-bed to planting out the budded trees in the grove.

THE REMOVAL OF THE BUDDED TREES.

In cases in which the budded trees are to be transported only from the stock-nursery to another part of the same farm, they may be cut back to the trunk and removed with naked roots. This is best done by placing a small length of ten inch pipe over the tree and driving it into the soil so that all the lateral roots are cut and the tap-root may then be severed by a spade. The tree is thus removed with the minimum damage to or interference with the root system.

When, however, it is necessary to transport the trees a longer distance the trees should be "balled," that is, a trench about one foot wide and fifteen inches deep should be dug between the rows of budded trees, the tap-root cut and the tree removed with a ball of soil around the roots, which should be wrapped in sacking.

SELECTION OF THE SITE FOR THE GROVE.

Soil:—Citrus can be grown profitably on a wide range of soils—from a fine sandy soil to a heavy red loam. The ideal soil, however, is a deep rich, well drained, sandy loam.

The mistake must not be made of judging a soil by what can be seen on the surface, for it may be found on digging to a depth of a few inches that there is a "hard pan" through which the roots would be unable to penetrate, or, on the other hand, that the subsoil is so coarse that it is unable to retain water and is lacking in plant food.

"Acid" soils should be avoided. Such a condition occurs in swampy land or in soils containing a high percentage of humus. This condition can be removed by the application of lime.

Situation:—Citrus trees grown in exposed situations are unfavourably affected by strong winds; the young foliage and flowers may be blown off, the fruit may be scarred by coming into contact with each other or with thorns, and the shape of the trees may be unsymmetrical. So, exposed situations should be avoided or if the soil is so suitable as to tempt one to establish a grove, wind-breaks should be established by planting rows of quickly growing trees. The silk oak (*Grevillea robusta*) or Eucalyptus makes good wind-breaks. But, they should not be allowed to grow too tall or too thick. An objection to trees as wind-breaks is that they tap the food supply of the adjacent fruit trees, but this objection may be overcome by trenching between the rows of wind-break trees and the fruit trees, thus severing the lateral roots of the former.

Sunlight:—A generous amount of sunlight is necessary for the growth of the trees, as it is essential for the process of nitrification which take place in the soil, but in dry situations an excess of sunlight may cause 'scalding' of the fruit and foliage.

Atmospheric Conditions:—Generally, scale insects and epiphytes prosper under humid conditions, the fruits are slower in ripening, but the trees bear more prolificly and the crop tends to be more or less continuous than under the reverse conditions. Low humidity causes the fruit to be a deep rich colour.

THE PLANNING OF THE GROVE.

When planning a grove three considerations should be borne in mind—symmetry of the grove, economy of space and the convenience of operations in connection with the management of the grove.

There are three systems of lining out a grove which fulfil the three conditions stated above in different degrees—the square, triangular, and hexagonal systems.

In the square system of planting the trees are planted at right angles as distances varying from 18ft. × 18ft. to 35ft. × 35ft. This system permits of cultivation by machinery in two directions.

In the triangular system the trees are planted in rows, but in every alternate row the first tree is planted equidistant between the first and second trees of the preceding row. This system permits of cultivation by machinery in three directions, but reduces the number of trees per acre.

In the hexagonal system six trees are planted equidistant from each other in the form of a hexagon and a seventh in the centre of the hexagon. This system permits of the greatest number of trees per acre.

The usual distances for planting the several species of Citrus are—tangerine, 20ft. × 20ft.; navel orange, 22ft. × 22ft.; other oranges, lemon grape-fruit, 24ft. × 24ft.

Number of Trees per Acre for Different Systems.

Species	Square	Triangular	Hexagonal
Tangerine	108	98	126
Navel Orange	90	—	103
Other Oranges	—	—	—
Grape-fruit	76	—	86
Lemon	—	—	—

THE PLANTING OF THE TREES.

The holes in which the trees are planted should be about two feet wide and about one and a half feet deep. If the sub-soil is stony or has a hard pan, it should be thoroughly loosened. To ensure that the trees will occupy the exact point that the stakes were placed a notched board should be used for guidance. The method of planting varies somewhat, depending on whether the trees have naked roots or are balled.

When naked root trees are being planted any broken roots should be carefully cut cleanly. Care should be taken to see that the fine soil is evenly distributed between the roots to obviate the chance of the roots dying owing to their not being in contact with the soil. The stems should be cut back and the cut surfaces waxed or tarred.

When balled trees are being planted the balls of soil and sacking around the roots should be allowed to remain, only cutting the string binding the sacking.

In both cases care must be taken to see that the trees are not planted too deep, that is, that the soil does not extend to the point at which they were budded. Deep planting, especially in the plains, has resulted disastrously. In such situations it is advisable to fill in the hole in such a manner that the tree is planted on the summit of a cone and the washing away of the soil in the course of time results in the exposure of a few inches of the larger lateral roots.

Care must also be taken that the trees are firmly set in the ground and that they are thoroughly watered.

CULTIVATION.

One of the main objects of cultivation is to produce a fine soil mulch in order to prevent over-evaporation of moisture from the soil. Furthermore, by thorough cultivation soil aeration is increased, resulting in a large supply of plant food being rendered available. Cultivation breaks up the particles of the soil and the smaller the particles the larger the area exposed to the solvent action of the roots; moreover, the finer the soil the more easily is it penetrated by the root system, which becomes more extensive, and co-ordinate with the more extensive root system is the increased vigour of the plant and increased resistance to disease. Also, proper cultivation improves the conditions for the development of the bacterial organisms in the soil whereby more food is rendered available.

Where it is not possible to cultivate by machinery—by plough followed by disc harrow—it should be done by light spading fork, care being taken that the roots near the plants are not injured.

Two points should be borne in mind: that cultivation should be deeper on heavy than on light soils, and that it should not be done when the soil is either too wet or too dry.

FERTILIZATION.

Given that the soil has been properly cultivated and is as a consequence capable of absorbing and retaining moisture and is well aerated, our soils are usually rich enough to make it unnecessary to fertilize the grove until it is a few years old.

Citrus draw from the soil nitrogen, phosphoric acid and potash constituents. In California the system of fertilization is to apply per acre 6 to 8 lb. of bone meal in October by drills, 2 lb. of sodium nitrate in March by hand-spreading, 12 to 15 lb. of tankage in April by drills, and 5 to 10 cubic feet of stable manure in August. The Californian furrow-method of applying stable manure to old trees could be adopted here with advantage. This method consists in digging furrows, six to ten inches deep, near the drip of the branches, putting the manure in the furrows and covering the furrows with soil.

MULCHING.

Mulching with any sort of vegetable matter, but preferably with leguminous, is highly desirable in heavy soils and especially in the tropics, for the decay of the material used for mulching adds humus to the soil and in hot countries humus is quickly burned out of the soil.

Humus in the soil increases the water-absorbing and retentive powers of a light soil; it makes a heavy soil more workable, thus increasing the aeration thereof, and it increases the nitrogen content of any soil.

COVER CROPS.

Cover crops in the Citrus grove have many advantages and but few disadvantages. They have the advantages of increasing the fertility of the soil, of improving the physical condition of the soil, of increasing the soil bacteria, of adding atmospheric nitrogen when the cover crop is leguminous, and of preventing erosion of the soil on hillsides. On the other hand, they have the disadvantage of causing root-pruning incident to the cultivation of the cover crop, which is not advisable while the trees are blooming or bearing. In Jamaica cow peas and peanuts are probably the best cover crops.

INTERCROPS.

The practice of intercropping, that is, of growing crops between Citrus so as to obtain some revenue while the grove is unproductive, is to be recommended only when the intercrops are such that they do not interfere with the well-being of the main crop. But, the practice of handing over parts of the grove to small settlers to get what they can out of the land in return for the upkeep of the grove is not to be recommended.

Vegetables, such as tomatos, peas, beans and potatos, may safely be grown as intercrops.

REMOVAL OF EPIPHYTES.

Such epiphytes as "old man's beard," tree-pines and lichens, which tend to cause the tree to become "bark-bound" besides being unsightly, should be removed and the tree maintained in a clean condition.

PRUNING.

On this subject there is a great diversity of opinion amongst growers and this is rather as it should be, for there is as much individuality amongst Citrus trees as there is amongst children.

The chief object of pruning is to develop trees of such size and condition as to make it possible for the trees to produce a large crop of A quality fruit.

The custom has been to prune Citrus trees only in so far as to remove dead branches and water-sprouts. The result of such a system of pruning is a tree of dense, impervious foliage growing close to the ground with the fruit distributed on the outer branches.

Old or decadent trees will usually respond to judicious pruning if the soil conditions have been improved by fertilization and thorough cultivation. In the case of young trees there is usually adequate sunshine and ventilation which are so essential to the process of nitrification which takes place in the soil, but when the trees become larger the overhanging branches restrict the amount of light and in addition prevent the cultivation of the ground beneath them and this portion of the ground becomes hard and provides a smaller amount of nourishment, so that at the time when the trees being larger require more nourishment, the available nourishment is actually lessened. So, such branches should be removed so as to permit of the access of sunlight to the soil and the cultivation of the ground beneath them. By heavy pruning almost the same amount of nourishment can be made available to the old trees as was available at the earlier stages, other conditions being equal.

All suckers, crossed, devitalized and dead branches should be removed and burned.

Pruning, however, must not be regarded as a substitute for cultivation, but as a supplementary measure to stimulate new growth and for the removal of undesirable growth and devitalized branches.

Pruning should be done in the early Spring. All the cut surfaces should be tarred.

TOP-WORKING.

It may become necessary to change the grove from one variety of Citrus to another and this may be done by top-working by one of two methods:

1. By cutting off the whole top and budding into the trunk or into the stubs of the larger branches.

2. By cutting the top back, leaving the branch stubs and budding into the shoots which grow from these stubs.

In either case 'safety' branches are left, in order to draw the sap and to prevent the buds from being 'drowned out.' Large buds should be used and the hard bark from the old branches and trunk near the incisions should be scraped thin. After the buds have begun to sprout care should be taken that they are not crowded out by sprouts arising from the stock.

HANDLING OF THE FRUIT.

Citrus fruits should be handled with great care, for even a slight abrasion of the skin of the fruit may permit of the ingress of organisms, especially in damp weather, resulting in the decay of the fruit. Abrasions frequently occur during the actual picking of the fruit owing to the carelessness in handling of clippers, or by the picker's finger nails, or by thorns.

Attention should be paid to seeing that the fruit stems are smoothly cut, to obviate the risk of puncturing other fruit, and that the calyx is not removed so as to prevent the ingress of decaying organisms at that point.

The fruit should be placed as soon as they are picked in boxes for transportation to the packing house, but these boxes should not be filled to the brim so as to avoid damaging the upper layer of fruit. On arriving at the packing house the fruit should be washed to remove dirt and sooty mould in water to which has been added permanganate of potash, 1 lb. to 1,000 gallons of water. This also serves to disinfect the fruit, killing any organisms which set up decay and which may be present. Washing may be done by passing the fruit through a machine consisting of revolving brushes on which a stream of water is directed, or by hand. The fruit is then conveyed by a system of belts to the drying racks and thence in the same manner to the graders where the fruit is graded in accordance with shape, colour and condition. The fruit is then graded in accordance with size, being passed through a sizing machine. The fruit is then taken from the sizing machine by the packers, wrapped in soft tissue paper and packed in boxes in accordance with their size. The size is determined by the number of fruit required to fill a box.

PESTS OF CITRUS.

The Citrus grower will be confronted with the problem of the control of insect pests. It may be even as soon as his nursery has been established, but sooner or later he will have to tackle the problem.

The most important Citrus pests in Jamaica are scale insects and the Citrus Black Fly.

Of scale insects there are no less than sixteen species recorded as attacking Citrus in this Island. Of the most injurious are the Orange Snow Scale, *Chionaspis citri*, which attacks the larger branches ; the Purple Scale (known locally as the Mussel Scale), *Lepidosaphes beckii*, which may be found thickly encrusted on the branches, young twigs, leaves and the fruit; and *Selenaspidus articulatus*, which attacks the foliage and the fruit.

The Citrus Black Fly, *Aleurocanthus woglumi*, is unfortunately only too well known to all Citrus growers in Jamaica.

The grubs and adults to the Fiddler beetle have by their girdling of the main roots been responsible for the deaths of a large number of Citrus in certain parts of Manchester. From the facts as stated to me it appears that the trees were being grown in very light soil, so friable that it was possible to push a stick into it to a considerable depth. In localities, therefore, subject to attacks by this insect light soils should not be selected, or, if selected, cultivation should only be carried out to the extent of maintaining the grove free from weeds.

For fuller information with regard to the insect pests of Citrus the reader should refer to pages 29-42 of Entomological Bulletin No. 2 of the Department of Agriculture of Jamaica—"The Principal Agricultural Pests of Jamaica".

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FOOD STUFFS.

CASSAVA OR MANIOC IN CEYLON AND ITS CULTIVATION.

W. MOLEGODE,

Agricultural Instructor.

Cassava or Manioc (*Manihot utilissima*) was, it is recorded, introduced to Ceylon in the year 1792 by the Dutch Governor VAN DE GRAAF, who "by disseminating information widely in the Sinhalese and Tamil languages as to the best mode of cultivating the plant, succeeded in making its merits known." But Cassava did not become a cultivated crop until much later. As far as can be ascertained it was fairly extensively cultivated in the Tamil districts in the middle of the last century. THE COLOMBO OBSERVER (now the CEYLON OBSERVER) of the 7th June, 1852 says "The Cassava plant will grow anywhere in Ceylon and it is cultivated in considerable patches by the natives of Jaffna for the sake of its yams." At the present time Cassava is more widely cultivated than any other tuberous crop. Its cultivation has spread far and wide in Ceylon owing to its growing popularity as an article of cheap food and throughout the country cassava plantations of various sizes from several acres to small patches are a prominent feature in village agriculture. During the food crisis in 1919 cassava or manioc contributed more largely than other crops to the food supply of the country. The people are getting more and more accustomed to the use of manioc as a food and there are indications that it will assume an important place in the dietary of the peasantry.

In many other countries where cassava or manioc is cultivated the manufacture of Starch or "Tapioca flour" is an important industry and the possibilities in Ceylon in this direction are worth enquiring into.

VARIETIES.

There are now a large number of varieties of manioc grown in the Island. In recent years several varieties have been introduced, chiefly from Mauritius. Locally the several varieties are classed under two heads—*Sinnokka* and *Mannokka*.

CULTIVATION.

Soil and Climate.—This crop thrives under varying conditions of climate and types of soils, and can therefore be grown almost throughout the Colony. It is a very successful drought-resisting plant, and once provided with sufficient moisture to start the growth of the plant, it might be said that manioc is immune to drought. When the plants become well established, although an occasional shower of rain will help considerably, the crop will never be a total failure owing to want of rain, nor does excessive rain, unless grown on heavy undrained soils subject to water-logging, affect the crop. Except on swampy and low heavy soils, manioc will thrive and give good results in all other soils. It is this indifference to climatic and soil conditions that makes the cultivation of manioc possible throughout the Colony.

Culture.—The plant is propagated from stem cuttings which are taken from the middle portion of sound plant stalks. The basal woody parts and ends of branches should not be planted. The soil for manioc should be dug up fairly deep—at least 10 or 12 inches and cuttings planted in shallow pits or holes at distances varying from 3 to 5 feet according to the variety grown, soil and other conditions. If the soil is poor or the situation very dry, close planting should be adopted, There are various methods of planting the cuttings. Some growers plant two cuttings, which are 9 to 12 inches long, per hole, putting them cross ways like an × burying about 2 or 3 inches of the cutting in the soil. Some plant three or four cuttings round the hole putting them in a slanting position. Others bury the cuttings horizontally about 2 inches deep in the soil. Another method is now becoming popular and is being widely adopted. That is to plant the whole length of the stalk of the plant. This manner of planting is by inserting the lower end of the stalk into the soil about 2 or 3 inches deep and in order to secure the growing plant against the force of wind the plants are tied to stalks provided for them. It is contended that by the adoption of this method of planting entire stalks a much quicker yield is obtained.

The time for planting depends entirely on existing conditions. As stated before, a certain amount of moisture in the soil is necessary to start growing. The best time to plant is when a short period of rain is expected.

Once the plants are established hardly any further cultural treatment is necessary.

Manioc is comparatively free from attacks of uncontrollable pests or diseases. Wild pig and the bandicoot are great pests on manioc but these are easily dealt with. Fresh cuttings before they take root are attacked by white ants. Application of a little lime or potash will keep off white ants.

HARVEST AND YIELD.

The time of lifting the crop depends on the variety grown. There are early and late varieties. Some varieties are fit for lifting in three to four months. Others take six to nine months. By the adoption of the entire stalk method of planting the time of lifting the crop is greatly reduced in the late varieties. When plants begin to flower the tubers are mature enough for eating. The surest test is to lift a bush or two and see the stage of maturity.

The tubers do not keep well for any length of time when they are removed from the soil and those exposed to the air for three or four days should be used with care. The yield varies very considerably, depending largely upon the variety, soil, climate, and length of time tubers are allowed to develop in the soil.

A cultivator in Tumpane, near Kandy, lifted a crop of 60,000 lb. from 2½ acres in the eleventh month after planting. The method adopted by him was to plant 8-inch cuttings 4 feet apart, putting two cuttings per hole horizontally and covering them with 2 or 3 inches of soil.

USES OF MANIOC.

The chief use of manioc in Ceylon is as a poor man's food. It is used very extensively both by the Sinhalese and Tamils as a principal diet during many days of the year. It is boiled and eaten as a vegetable. It is cooked

as a curry, and it is sliced, dried and pounded into flour, which is used in the same way as rice flour for baking bread and cakes. Here and there in the Island the manufacturing of manioc starch is becoming established as a home industry. A considerable amount of tubers are now turned into "Meal" or "Chips." It is probable that before long Ceylon will start the manufacture of Cassava Starch or Tapioca flour as a commercial industry.

FOOD VALUE.

The following analysis made at the Laboratory of the Colonial Museum at Haarlem has been published, giving the results of fresh and dry samples respectively :—Nitrogen 0·26 and 0·50%; Albuminoids 1·63 and 3·30%; Fat 0·94 and 1·90%; Carbohydrates (expressed as starch) 39·79 and 80·60%; Crude fibre 2·10 and 4·25%; Ash 0·24 and 0·48%.

The fresh sample contained 50·63% water.

The following tabulated results of an experiment in Jamaica will show the variation in the yields and the quantity of starch :—

Variety	Yield of Roots in Tons Per Acre			Quantity of Starch in lb.		
	At 12 Months	At 15 Months	At 21 Months	At 12 Months	At 15 Months	At 21 Months
1	8·25	14·2	21·9	5,636	9,733	15,818
2	6· 5	6·5	18·0	4,878	5,197	15,433
3	7· 5	11·5	19·3	5,494	8,553	13,883
4	5·75	11·1	18·0	4,160	8,180	13,277
5	9. 0	15·4	15·4	6,552	12,857	13,187
6	10· 5	11·0	11·6	7,902	7,638	8,753
7	6·75	8·1	9·0	5,322	6,540	7,102
8	7· 5	9·7	10·3	5,337	6,931	6,547

PREPARING OF CASSAVA FLOUR.

The following is a simple method of preparing cassava flour. The roots are skinned, split and cut into pieces a few inches long and about an inch thick, or sliced into smaller chips. These are dried in the sun until very crisp. In this state the chips can be kept for a long period. When required the chips are pounded in a rice mortar and passed through a sieve to separate the flour from the fibre.

STARCH MANUFACTURE.

As stated earlier, the manufacture of starch or "Tapioca flour" of commerce is an important industry in other countries, where Cassava is extensively cultivated. Tapioca is not only a well-known food, but is largely employed in the dressing of cotton goods, paper, soap and paste industries, and in making starch, sugar or glucose. Before Cassava starch came into the market as a cheaper source of dextrine and glucose, the commercial world had to depend chiefly on corn and potato starch. Corn and potato being more important food crops any starch that could replace them was bound to become popular, and consequently what was not long ago an unimportant industry was soon established on a sound basis. The extent to which Cassava is cultivated now in Ceylon and considering what an enormous increase is possible, it is worth establishing a central starch manufacturing factory.

One thing essential for the manufacture of the starch, as will be seen later, is an abundant supply of pure water. The first important thing to do is to wash the tubers thoroughly, as even a little dirt will affect the purity of the starch. Elaborate machinery has taken the place of old crude form of extracting the starch, and the process of manufacture has been reduced to perfection. One method of extraction is as follows: The roots are washed, scraped and milled. The pulp is then driven upward by a stream of water against a wire-gauze diaphragm through which the water and starch pass. Instead of allowing this mixture to settle in still tanks it is piped to near the bottom of a tank which has the form of a large inverted cone in which the water flows upwards. As the cone widens upwards the flow decreases until it becomes so slow that the starch settles against it, only the dirty water flows off at the top, and the starch is drawn off below. Another method is to run the pulp over long sieves placed on an inclined plane, where it is acted upon by streams of water. The sieves are subjected to interrupted lateral motions so that the wet pulp is shifted about, constantly subjected to the jets of water thrown upon it. The milky starch which passes through the sieves flows into tanks, where the starch is repeatedly washed to separate out the impurities.

A simpler process is described as follows:—First the roots are well washed. They are then milled on a rough cylinder. The pulp is now run through a trough with a sieve bottom, thus straining out the fibrous parts. The trough is constantly shaken and jets of water are made to play upon it. The washed material is allowed to settle in a tank and the water is run off. The starch is again and again washed in clear water and finally it is dried.

It is important to remember that the starch is contained in small cells, and consequently the milling or crushing of the roots must be very thorough, and the straining should be through fine sieves so as not to allow any particles of the fibre to get into the starch. Clean pure water only should be employed.

CASSAVA POISONING.

Fatal cases of poisoning by eating cassava or manioc yams have occurred in Ceylon. The tubers, more specially those injured, if kept exposed to the air after they are removed from the soil, may develop poisonous properties and therefore when used as a food it is not safe to keep the tubers longer than two or three days. In any case it is safer to boil or cook cassava yams thoroughly.

The poisonous properties develop largely in the internal layer of the inner part and it is therefore necessary that the rind should be carefully removed and the root well scraped.

If in boiling cassava the water is changed once or twice the fear of poisoning is reduced. After about 10 or 12 minutes' boiling, drain off the water and boil in fresh water.

Symptoms of Poisoning.—There would be great weakness. The limbs will be cold and a weak fluttering pulse.

What to do.—Place the patient in the open air near an open door or window; empty the stomach by inducing vomiting; apply cold water to the head and spine or remove the clothes from the body; and pour cold water

from a height on the back of the head, spine and chest. Afterwards dry and put on warm clothes; apply smelling salts to the nostril off and on. As soon as the stomach is emptied give a strong doze of whisky or brandy; rub the arms and legs briskly. If breathing is arrested, carry out artificial breathing.

A very simple treatment is to give the patient plenty of *kitul* treacle and lime juice.

[There are varieties of cassava which may be poisonous under certain conditions, and others which are harmless under all conditions The varieties grown in Ceylon are generally harmless.—ED.]

HINTS ON ONION GROWING.

The seed should be sown as soon as it is obtained because it quickly loses its power of germination. If it has to be kept for a time it should be put into a tin with a close-fitting cover or into a tightly corked bottle.

Sowing.—It is advisable to sow the seeds in boxes or in beds protected from the heavy rains which are fatal to the young seedlings. The seed-beds must be well drained and raised to a height of about one foot. Whether seed beds or boxes are used, the soil must be broken up fine and mixed with sand as the seeds are very small. The seed can be sown in rows 6 inches apart, or scattered broadcast, and then covered with about half-an-inch of soil.

Protection from Ants.—Ants are sometimes very troublesome and devour or carry away the seeds. The best and simplest way to prevent this is to first water the bed lightly with ordinary water and then with a mixture of kerosene oil and water in the proportion of one tea-spoonful of kerosene oil to one pint of water, which should be well shaken both before and during use.

Preparation of Beds.—Beds for growing onions require to be well-drained and thoroughly tilled and then liberally manured with well-rotted pen manure or leaf mould and wood-ashes, which must be well forked in. Afterwards the surface of the land must be made as smooth as possible.

Transplanting.—In about 5 to 8 days the seedlings will show above the soil and in about 8 weeks' time when the young plants are 4 or 5 inches long they will be ready for transplanting. This is most easily done when the ground is freshly prepared. It is recommended before transplanting that the tops of the plants and the ends of the roots should be cut off for convenience.

The rows should be marked out about 12 inches apart and the plants put in 3 or 4 inches apart in the rows. A small hole may be made with the finger or a sharpened piece of wood, the plant put in the hole with the base of the stem about one inch deep and the soil pressed down around it. It is advisable to choose wet weather for transplanting or the young plants will have to be watered for a few days until they are established. The beds must be kept carefully weeded and the surface soil should be kept loose by stirring it with a narrow hoe taking care not to disturb the plants.

Harvesting—In three or four months' time, when the leaves wither the onions will be ready to harvest. If the onions are harvested before they are ripe they will not keep well. When gathered, they should be spread out in a well-ventilated room or shed until they are quite dry, which will be in about two or three weeks' time.—JOURN. OF BD. OF AGRIC., BRITISH GUIANA, Vol. XVII, No. 1.

PADDY.

PADDY MANURIAL EXPERIMENTS IN ILLUPUDICHENAI, 1923-24.

The following are the results of Paddy Manurial Experiments carried out by Agricultural Instructor THAMBIAH at Illupudichenai during 1923-24.

From these results it will be seen that Plot No. 2 has given the best results. Plots 2, 4 and 6 were all manured with 37½ lb. of bone meal, but weeding was done only in the case of Plot No. 2 which gives the biggest yield both in paddy and straw. To get good yields therefore manuring and weeding should go hand in hand.

RESULTS.

Serial No.	Nature of Work	Plot No. 1	Plot No. 2	Plot No. 3	Plot No. 4	Plot No. 5 (Control Plot)	Plot No. 6
1	Area	¼ of an acre	¼ of an acre	¼ of an acre	¼ of an acre	¼ of an acre	¼ of an acre
2	Seed	Selected	Selected	Selected	Selected	Unselected	Unselected
3	Name of Paddy Variety and age	Perilla nel 4 months	Perilla nel 4 months	Perilla nel 4 months	Perilla nel 4 months	Perilla nel 4 months	Perilla nel 4 months
4	Quantity Sown	1 Marakkal 5¼ measures	1 marakkal 5¼ measures	1 marakkal 5¼ measures	1 marakkal 5¼ measures	2 marakkal 5 measures	2 marakkal 5 measures
5	Date Sown	29. 10. 23	30. 10. 23	30. 10. 23	30. 10. 23	31. 10. 23	31. 10. 23.
6	Ploughing	Early, *i.e.* first Ploughing in June	First Ploughing in June	First Ploughing in June	First Ploughing in June	No ploughing	First ploughing in June
7	Manures Name & Quantity	No manures	37½ lb. Bone Meal	No manures	37½ lb. Bone Meal	No manures Control Plot	37½ lb. bone Meal
8	Weeding	Weeded	Weeded	No weeding	No weeding	No weeding	No weeding
9	Yield of Paddy per acre	32 bushels	48 bushels	27½ bushels	29 bushels	25 bushels	28½ bushels
10	Yield of Straw per acre	590 lb.	912 lb.	495 lb.	512 lb.	409 lb.	457 lb.
11	Expenditure per acre	Rs. 48·76	Rs. 58·76	Rs. 45·76	Rs. 55·76	Rs. 45·52	Rs. 55·52
12	Order of Yield	2nd.	1st.	5th.	3rd.	6th.	4th.

YIELD OF PADDY AFFECTED BY THICKNESS OF SEED-BED.

F. R. PARNELL,

Government Economic Botanist.

On a previous occasion, YEAR BOOK, 1920-21, page 114, figures were given showing that the degree of sturdiness of the seedling, in transplanted paddy, affects the yield of the resulting crop very considerably. The seedlings used in that experiment were selected types from an ordinary seed-bed. A somewhat similar experiment was conducted last season, 1921-22, but in this case the different classes of seedling were raised by sowing seed-beds at different rates.

The variety used was a pure strain of the local Tulukka Samba. Seed-beds were sown, all on the same day and after similar preparatory treatment, at four different rates, as follows :—

(1) Normal	1 M.M.	(2½ lb.)	in 1 cent.
(2) ½ ,,	do	do	,, 2 ,,
(3) ¼ ,,	do	do	,, 4 ,,
(4) ⅛ ,,	do	do	,, 8 ,,

The seedlings varied considerably in the different beds, the general sturdiness and tendency to tillering increasing as the seed-rate decreased. Each type was planted on eight strips 40 ft. by 40 ft., two repetitions in each of four plants, the seedlings being spaced 6 inches apart each way. The whole planting was finished in one day and the after-treatment was the same for all.

There were very marked differences in growth in the early stages the thinner sown seedlings becoming established more quickly and making better growth. Later growth evened up the differences to a great extent but the quarter and eighth normal types flowered five days earlier than the other two.

All strips were harvested and the grain weighed separately. The grain yields are given below but, for simplicity, the two similar strips in each plot are added together, the figures showing the yield from each plot only for the four types.

Plot	Normal	Half Normal	One-fourth Normal	One-eighth Normal
2 E	124	131	135	145
3 E	140	150	143	148
4 E	117	132	139	135
5 E	126	137	147	148
Total	507	550	564	576
Relative	100	108·6	111·4	113·8

These results confirm those of the previous year in showing that a substantial increase in crop results from decreasing the seed-rate. It is probable that the increased crop resulting from a reduction of the seed-rate to 1 m.m. in 2 cents would, in very many cases, more than cover the extra cost of preparing a greater area of seed-beds. A point to be considered is that the seed-bed area would not have to be doubled as the seedlings from 1 m.m. of seed would go further, in planting, if sown more thinly in the seed-bed.—MADRAS AGRIC. DEPT., YEAR BOOK, 1923.

LIVE-STOCK.

RESEARCH ON LIVE-STOCK.

PROFESSOR J. SYDNEY DASH, B.S.A.

It is generally recognized that the quality and quantity of live-stock in a community is a good indication of the agricultural progress and development of that community. Unfortunately this important consideration in agricultural progress has hardly been given the attention it deserves in the tropics where everything is expected to flourish with little or no direction by man. To a northern agriculturist who has learnt to appreciate to the full the value of live-stock, the lack of care so frequently seen is little short of amazing, while a tropical visitor to Smithfield or Chicago might wonder how it could be possible to secure the quality and finish so much in evidence at those great live-stock shows. It is true the business side of animal production, like so many other branches of agricultural effort, has been seriously neglected in the tropics and scarcely any reliable figures exist as to feeds, feeding, gains, and costs. Rarely is an animal ever weighed, except when offered for sale. Little attention has been paid to the keeping of accurate animal records, and in the case of working stock, crediting them with work performed as is done in countries where systematic cost accounting is practised. The general appearance of an animal is taken as an indication of the suitability or otherwise of the food and care given.

Concerning the question of general care, attention might perhaps be drawn to certain remarks on rumination by MR. BEGG in a recent number of the "VETERINARY RECORD". "In properly conducted byres, the factors that are potent to excite the cattle and so disturb rumination are carefully eliminated, because it is well recognized that only under a regime of almost perfect quietude in the cowshed, gentleness in handling of the cow, and an almost entire absence of circumstances, that by sight or hearing, or sensation upset the natural complacency of the cows, can the maximum yield of milk be obtained. The exceeding value of suitable periods of rest and quietude, to permit of proper rumination, is well understood by those experienced in charge of yoke oxen. Although this interferes materially with the speed of the trek, it must be provided for, otherwise the animals soon fall off in health and condition, and are incapacitated for further work".

Failure to recognize the importance of rumination is no doubt one of the many causes of ill-conditioned working herds so frequently seen in tropical countries. Another consideration to which some attention might be given is that of regulating the hours of work. With efficient management, heavy work such as ploughing is not usually done in the heat of the day but confined where possible to the early and late hours of the morning and afternoon respectively. The care of pastures particularly in respect to shade, drainage, tick infestation and water supply often leaves much to be desired

Such a condition of affairs is perhaps surprising since animals are required in large numbers for labour, meat, and milk, apart from the value of the manure produced—the latter a most important consideration where exploitive agriculture is yearly taking a heavy toll of the fertility of tropical soils. The situation may indeed be regarded with some alarm even in countries specially favoured by nature and where intensive and deep tillage has been resorted to in order further to tap the potential resources of the soil. In any case, successful permanent agriculture depends on the extent to which soil losses are made good, and in this connection it is the humus supply, so easily depleted under tropical conditions, that above all must be maintained. The relationship between crops, stock, and humus has long been understood in settled agricultural countries.

As an example of a successful live-stock country with tropical conditions, we may take the case of India. In 1920 it was stated to lead the world in number, being credited with 318,000,000, including cattle, buffalos, sheep, goats, mules, horses and donkeys. In 1916-17, the value of skins, raw and tanned, exported from India amounted to £15,800,000. This perhaps should be taken as a tribute to the work of the various Departments of Agriculture in the suppression of pests, and to the care and patience of the native whose reputation as a stock man is well known in the West Indies. Other countries in the tropics do not seem to be favourably placed, on the other hand ; figures at the moment are not available, except for Mauritius, which according to the statistics in 1919, showed a decrease of 8,000 head during the previous four years. In the West Indies, the large number of animals imported every year indicate that there is abundant scope for home production, and the raising of stock should be given greater consideration in the economy of many estates than it is at present. The price of a commodity such as pork so easily raised with home-grown foods should be an incentive to proprietors, both large and small, to keep pigs, if only on a small scale. Moreover, with the world's present overproduction of grains and cereals and the underproduction of animals and animal products, the prices of the latter will tend to keep high.

Being mainly occupied with crops, Agricultural Departments in the tropics have not, in the past, given sufficient attention to the live-stock question, at least in all its phases. It has become increasingly evident that animal studies must go hand in hand with plant studies if agricultural industry is to be fostered and maintained. As in England, private individuals have done much to introduce new breeds and strains and to encourage live-stock associations. Governments have emulated their example and in many cases extended considerably this line of activity to include the breeding of types suitable for special conditions and also the study and treatment of diseases and pests. Much remains to be done, however, on problems connected with animal nutrition. What is a ration? In the present state of our knowledge, is a satisfactory answer to this question possible in respect to tropical requirements for maintenance and production (including work)? Obviously not. It has been left to northen countries to show us the value of such tropical feeds as coconut and cotton seed meal, and we rely largely on their experiments as a guide in using these substances. Similarly, the true value of molasses as a stock food is but imperfectly

understood. These are only three of the many useful feeds that the tropics can produce abundantly ; as is well known, unlimited possibilities exist for the production of many others. At present, the tendency is to sell cheaply and buy dearly our principal stock feeds.

In conclusion, while much has been done in the selection and breeding of animals suitable to tropical requirements, the importance of using only male animals of superior character in the grading up of herds, whether for milk, meat or work, needs to be emphasized and brought home to all those engaged in agriculture in the tropics. Efforts to increase the number and quantity of all kinds of live-stock by better breeding, care and management, should be encouraged in every way. But above all, what is required is organized research to study problems relating to animal nutrition, to study feeds, feeding and costs and to disseminate this knowledge so that stock raising may become a stabilized business in the tropics, which can produce all the feeds required, instead of the uncertain, haphazard venture it now appears to be. Intimately associated with and almost unseparable from such problems are those of maintaining the fertility and humus content of tropical soils, which also offer a wide field for research. The investigations now in progress at Rothamsted should stimulate tropical workers as to the possibilities awaiting them in this direction. Given facilities, the Imperial College of Tropical Agriculture would be in a position to undertake research work along the various lines indicated and to combine it with that on tropical crops, the necessity for which was clearly put forward in the last number of this journal.—TROPICAL AGRICULTURE, Vol. I. No. 2.

THE FEEDING OF ANIMALS.

PROFESSOR T. B. WOOD, C.B.E., M.A., F.R.S.

Drapers Professor of Agriculture, and Director of the Animal Nutrition Research Institute, University of Cambridge.

The feeding of animals is undertaken for the most part with the object of converting the coarser produce of the soil into animal products for human consumption. This is at once both wasteful and necessary : wasteful because on the average the food-producing live-stock of Great Britain consume about 40 lb. of the produce of the soil, weighed in the dry state, for every lb. (also weighed dry) of edible animal product they produce ; necessary because it is only through the agency of animals that the coarser and more bulky produce of the soil, such as hay, straw, grass and roots, can be converted into human food.

Granted the necessity for this wasteful form of food production, it is clearly most desirable that every effort should be made to reduce the wastefulness to its lowest possible limit. Hence the need for research in animal nutrition.

Broadly speaking, two kinds of research are required. In the first place we need scientific research into the fundamental aspects of nutrition, which to the man in the street may appear to be as far removed from agricultural application as were FARADAY'S experiments with a magnetised needle in the cellar of the Royal Institution from their present-day application—the electric motors which propel the underground trains and

the dynamos which provide them with the power they need. Secondly, we require practical research, which is, or should be, concerned with working out the practical application of the ideas originated by the fundamental investigators.

Both these types of work are in progress in Great Britain at the present time, the former being chiefly concentrated at Cambridge; at the National Dairy Research Institute at Reading; and at the Rowett Research Institute at Aberdeen. The more practical research into the application of fundamental principles to the practice of economic feeding is at present undertaken, not only by the three Research Institutes mentioned above, but by most of the agricultural colleges and by some of the farm institutes and country organisers connected with the country councils. In this branch of the work there is room for the organisation of team work. At present each investigator works on independent lines, which is excellent for really original research but is apt to fail in yielding reliable practical results of immediate general application. Notable exceptions are the excellent practical results which have been obtained in several areas by the rationing-for-milk schemes worked in connection with milk recording.

The Cambridge Animal Nutrition Institute has worked chiefly at the general relation between the quantity of fodder consumed and the quantity of meat produced, and its more important results have recently been published in a small volume entitled ANIMAL NUTRITION, written by the Director and published by the University Tutorial Press. This volume sets out a system of rationing all kinds of animals in accordance with the result which the feeder desires to produce. A second section of the Institute, under the direction of DR. F. H. A. MARSHALL, F.R.S., Reader in the University in Agricultural Physiology, has investigated the physiology of reproduction in farm animals. Perhaps its most important achievement is the demonstration that sterility in mares and cows is frequently caused by the persistence of the "yellow body" in the ovary. This has been given practical application in a simple operation by which the "yellow body" is squeezed out, when the animal again becomes capable of breeding. Other problems which have engaged the attention of the Cambridge staff are the separation and characterisation of the proteins of various fodder crops, the strength of wheat flour, the digestibility of various home-grown fodders, and the growth and development of various breeds of live-stock. A poultry section has recently been added to the Institute.

The Rowett Research Institute at Aberdeen, under the direction of DR. J. B. ORR, D.S.O., has only been completed since the war. It has, however, already developed a characteristic line of investigation, namely, the importance of the ash constituents of the diet on the growth and development, and especially on the health, of animals. This important subject has never received the attention it deserves, and in Great Britain has been scarcely touched. Already DR. ORR and his staff have clearly demonstrated that an inadequate supply of ash constituents produces an immediate and direct effect on the well-being of animals comparable with the effect of deficiency of vitamins, for which it is frequently mistaken.—JOURN. OF MIN. OF AGRIC., Vol. XXXI. No. 2.

PESTS AND DISEASES.

CONTROL OF ROOT-KNOT NEMATODES. EELWORMS ON FLORIDA TRUCK FARMS.

J. R. WATSON.

Perhaps some of the members may feel that a paper on nematodes is a bit out of place in a meeting of entomologists, but in our Southern States, at least, some one must tackle the problem, and generally the choice lies between the entomologist and the plant pathologist, and a nematode is certainly more closely related to an insect than to a fungus. Furthermore, the work of soil fumigation admits of wide application to injurious insects as well.

In our work in Florida we have approached the subject largely from the view point of the gardener and trucker. For the general farmer, and even for the farmer who combines considerable trucking with his staple crops, the cheapest and most desirable method of dealing with this pest is doubtless the time-honoured one of rotation of crops, growing for two or three years on the infested land crops more or less resistant to the nematodes, such as corn, grains, Brabham, Iron, or Victory cowpeas, velvet beans, etc. But the time involved is a serious objection to one practising more intensive trucking. He cannot afford to devote his high-priced land to the above-mentioned crops with their relatively low return per acre, and most truck crops are seriously affected by the root-knot organism. To meet the needs of the trucker an endeavour has been made to find a quicker method of controlling the pest. However, even for the intensive trucker, rotation of crops should not be abandoned. We have accumulated considerable evidence that there are among the nematodes strains which have become adapted to certain crops. We have repeatedly observed that when a crop of lettuce, for instance, heavily infested with root-knot, is harvested from the land, the land can at once be set out to celery with comparatively little damage, whereas a second crop of lettuce on the land is seriously affected. These observations are in direct contradiction to those obtained by BESSEY on this subject and will need careful verification by pot experiments before we can consider the question settled.

In all our work commercial control rather than complete eradication has been our aim. Florida soils, unless newly cleared, are so universally infested with nematodes that even if we should completely eradicate the pest from a piece of ground it would be very quickly reinfested from surrounding plots, as is newly cleared land. Our aim, therefore, has been rather to reduce the nematodes to such an extent that the farmer is able to grow a susceptible crop on the land during the next trucking season. This is much less expensive than would be complete eradication.

Our work has been largely along two lines, starvation and soil fumigation.

STARVATION.

The Florida trucking industry has a favouring circumstance in the fight against nematodes in that it is limited to the fall, Winter, and Spring months, leaving the land unoccupied during the Summer, the most active season for nematodes. Formerly it was almost universal to abandon the fields after the last truck crop was harvested to grass and weeds. Among these would be enough hosts of the nematodes to carry the infestation through the Summer. Furthermore, the heavy rains of the Summer compact the soil to the exclusion of the optimum amount of air as shown by the general acid reaction of such ground. These conditions tend to keep the nematodes in the encysted state so that they are carried over until trucking operations are begun again in the fall.

One of our earliest attempts to control nematodes in infested land was by means of the summer fallow, the idea being to keep the soil constantly stirred and aerated so that the eggs would be forced to hatch, and at the same time to keep the land barren of all vegetation, in order to starve out the nematodes. The land was accordingly ploughed and harrowed at intervals of ten days and after every heavy rain that packed the soil. A crust was never allowed to remain on the land. This kept the soil well aerated, and this in connection with the abundant moisture and high temperature of the summer season forced the eggs to hatch. As far as nematode control is concerned this procedure has worked out very well, but as was to be expected the effect on soil fertility is very deleterious. The hot sun on the bare ground and the heavy rains cause the loss of a large part of the plant food and are very injurious to soil organisms. However, the method is still occasionally used by a number of truckers who regard their farms only as a site for growing crops, expecting to buy their soil from the fertilizer salesman.

In an endeavour to avoid the injurious effects of the summer fallow we modified it by growing on the land some practically immune plant but maintained the constant cultivation and freedom from weeds, the idea being to shade the ground and thus prevent the injurious effects on the soil fertility; at the same time preserving the beneficial effects of constant cultivation. For a cover crop we turned to velvet beans for two reasons. In the first place they are practically immune to root-knot, being much more resistant than Brabham, or any other variety of cowpeas, and in the second place they make a rank growth during the summer time and completely shade the ground. It is to be observed that this method differs from the old method of crop rotation in that the land is kept under constant cultivation and a crust is never allowed to remain on the soil; also in the more careful elimination of weeds and grass. To secure this result, one or two hoeings when the velvet beans are young are necessary, and very frequently a hard weeding in the row as well. The results have been very satisfactory. Generally we have secured as thorough a control of nematodes in one summer from June or July to October as we secured by the older and more careless method of crop rotation in two or three years. In every case where the method has been carefully applied it has reduced the nematodes to a point where it was possible to profitably grow highly susceptible plants such as okra throughout the succeeding trucking season.

SOIL FUMIGATION.

Seed-beds present another problem calling for more complete eradication of nematodes, particularly in the case of crops like celery or lettuce, which are planted in the Summer when nematodes are most active. On the other hand, the limited area and the high value of the crops, justifies more expensive methods. Undoubtedly, steam or hot water is the most effective method of ridding the soil of nematodes, and where the trucker has steam handy it is undoubtedly the most satisfactory method of treating seed-beds, but unless the land is piped for steam we have found steaming a very expensive process. It was tried on the pine-apple lands of the East Coast but the cost was prohibitive. The same objection applies to hot water. The expense involved was largely that of transporting the boiler or other outfit from place to place.

We have tried carbon bisulphide and formalin and find them very good soil fumigants for nematodes, but on the whole we have had the best success, considering the cost, with a double treatment of sodium cyanide and ammonium sulphate. This was first tried, so far as the speaker knows, a number of years ago in California by PROFESSOR WOODWARD on a small scale. In practice, the soil is first saturated with a solution of sodium cyanide in water. We find that the dosage required will vary much with the type of soil. In general the lighter the soil the smaller the dosage required. On the sandy soils of the average trucking regions of Florida we have found that 600 pounds of sodium cyanide per acre is usually sufficient. This is applied in water and washed down with a liberal irrigation (most seed-beds in Florida are provided with overhead irrigation). Ammonium sulphate is then added at the rate 900 pounds to the acre. This is also washed down with a light irrigation. The ammonium sulphate acts on the sodium cyanide producing hydrocyanic acid gas. We find this method very effective, not only in killing out the root-knot organisms, but all animal life in the soil is killed. The seeds of most weeds are also killed, but those with large, heavy seeds will usually survive the treatment, as will also heavy Bermuda grass sod. Of course, covering the ground with some gas-tight material, such as tarred paper or a cloth treated with rubber (we have found the material from which the tents for fumigating citrus trees are made to be very satisfactory) will greatly increase the killing effects of the fumigation and reduce the dosage necessary.

The expense of this treatment is high. It costs nearly $1200 per acre, but as the acreage is usually small the above expense is not prohibitive for seed-beds. The residue, of ammonium sulphate, left in the soil increases the soil fertility and causes rapid growth of the plants.

We find that we can ordinarily safely plant the soil in ten days to two weeks after treatment. We have tried the sodium cyanide alone without the ammonium sulphate but the results were not nearly as satisfactory. The evolution of gas was not sufficiently rapid and the cyanide remained in the soil for a considerable time. It was difficult to get rid of it.

We are now experimenting with calcium cyanide, both in the form of dust and flakes. It would seem that we will be able to substitute this material for the sodium cyanide and ammonium sulphate at a greatly reduced cost. We have found the most satisfactory method of applying this material is to sprinkle it in the furrow when the land is ploughed.

DROWNING.

It has long been observed that lands regularly kept under water for several months each Summer were never seriously affected by nematodes. The flooding of the Everglades last year offered us opportunity to secure some data on the length of time necessary for eradication of nematodes. We found that soils continually under water for as much as six weeks still had plenty of nematodes, but fields submerged for four or five months were in all cases free. It would seem as if the time necessary to drown out the nematodes is too long to make this method of much practical benefit.—

JOURNAL OF ECONOMIC ENTOMOLOGY, Vol. XVII. No. 2.

SPRAYING AGAINST BLACK ROT OF COFFEE.

*** REPORT ON EXPERIMENT BY T. NARASINGA RAO,**

Coffee Planter, Chickmagalur.

Coffee is cultivated on a very large scale in Brazil which is the chief coffee producing country in the world. It is also cultivated in Jamaica, Java, Sumatra, South Africa, etc., the latter being only minor producers. It is also cultivated on an industrial scale in Southern India and forms one of the important industries of Mysore, being cultivated in the Districts of Hassan and Kadur and employing a very large amount of labour both local and imported. In Mysore, it is grown at an elevation ranging from 2,700 to 5,000 feet above the sea level. The coffee area in the State has an average rainfall of about 100 inches a year, most of it falling in the months of June, July, August and September. About 140,000 acres are under holding, of which a lakh of acres are held by Indians. The other 40,000 acres are held by Europeans. In all, about a lakh of acres are actually under cultivation. Almost the whole crop is exported and finds a ready market on the continent of Europe. The annual income from the industry ranges from 60 lakhs to a crore of rupees, depending on the price of coffee.

The chief diseases the plant is subject to are Borer, Leaf-disease (or *Hemileia vastatrix*), Koleroga or Black-rot. Recently, Green-bug, Stump-rot and Die-back have made their appearance. The actual loss from the various diseases is not less than 50% of the crop.

Black-rot or Coffee Koleroga :—This disease is found to exist in almost all the coffee estates of the Kadur and Hassan Districts, in varying degrees. The disease is very severe, and the heaviest loss is suffered by some of the planters whose estates are situated in the Taluks of Chickmagalur, Mudigere, Koppa and Sakalespur. The disease as will be seen from the places severely affected is closely associated with a heavy rainfall. In the

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* Report read at the Sixth Annual Meeting of the *Mysore Agricultural and Experimental Union on 15-12-1923.*

year 1918, when the South-West Monsoon was a total failure, the planters picked about 25 to 50 per cent. above their estimates. In Koppa Taluk where the estates are situated on a comparatively low elevation and where the annual average rainfall is about 150 inches, the disease is very severe and the greatest ravages are reported chiefly from this Taluk. In Mudigere Taluk also the estates with a heavy rainfall suffer most. Coming to Chickmagalur Taluk where the estates are situated at different elevations, the leaf-rot is found to be very severe on estates on the western slopes of the Bababudans, the estates on the eastern side suffering comparatively less.

The coffee Koleroga attacks the coffee plants during the rainy season. It begins to show itself about a month after the South-West Monsoon sets in. The disease is very severe in the months of July and August, and a part of September, and stops as soon as the monsoon is over. The younger plants in a new clearing are free from the disease for the first six or seven years and as they grow older, the disease begins to appear. First, a leaf here and there begins to turn black and gradually the whole plant turns black and all the leaves get affected. It attacks both the berries on the plant and the wood. The younger wood which is to bear the subsequent crop succumbs to the disease and the older wood resists the spread of the disease and often survives. On closer examination, we find a filmy cob-web-like layer of mycelium on the under-surface of the leaf. It is present on the whole of the under-surface completely covering all the portions of the leaf, from the leaf stalk to the apex. It can be peeled off easily and we find the mycelium has completely covered the petiole and the tender portion of the wood. The stalks of the berries turn black and also a portion of the berry itself turns completely black and falls off sometimes individually or in clusters if the disease is very severe.

At present the remedial measures adopted by the planters are that the rotten leaves are picked off, when the disease is spreading. Sometimes the operation is repeated several times during the monsoon months.

The first attempt by the Department to combat the disease was made about 7 or 8 years ago, when MR. (now DR.) M. K. VENKATA RAO was deputed to conduct spraying experiments on my estate. On account of there being no break in the monsoon though we waited for 2 or 3 days, we were not able to conduct the experiment at all, but we poured the mixture on some of the plants. It was observed that those plants did not suffer so heavily from rot.

Under the auspices of our Union, I undertook last year to conduct spraying experiments. Accordingly the Department was kind enough to spare me the services of MR. S. V. VENKATARAYAN, the Junior Mycologist. I think it will not be out of place here to mention something about the situation and the climatic condition of the estate. It is situated on the western slopes of the Bababudans at an elevation of 4,500 feet above the sea level. The average record of rainfall is about 80 inches, most of it falling in the months of June, July, August and September. The temperature in the monsoon ranges from 60° to 75°F. in shade.

In order that it may be under close observation, we selected, for our experiment, an acre of land adjacent to the estate bungalow. The experimental plot is planted 6 by 6 feet and it contains 1,200 plants to the acre. The plants are about 20 years old and they completely cover the ground, there being no vacancies. The shade trees are Silver-oaks and Nerale* which were also planted at the time of planting coffee. The field had been dug and the plants pruned in the months of March and April. The plants had put forth very good wood after the pruning and there was little or no crop on the plants on account of the rather heavy pruning. We took 20 rows of coffee of 60 plants each. This was divided into two big blocks of 600 plants each. Each of these was again divided into four blocks of 150 plants. So in all we had eight blocks of 150 plants each. The mixture was prepared as follows:—We took 48 measures of water and dissolved in it 5 lb. of copper sulphate. In another vessel we dissolved 5 lb. of lime in 48 measures of water. These two were mixed and tested to see if the copper sulphate was neutralized. To this resin boiled with soda was slowly added. The monsoon had already set in and we had to go on with the spraying slowly. Out of the eight blocks mentioned above, we sprayed every alternate block, the remaining four serving as checks.

To test how the spraying would act on unpruned plants, we sprayed about 50 plants in another portion of the estate. This block had not been pruned for the last 4 or 5 years and was nothing but a mass of wood. I am glad to inform you that the experiment was a complete success, though we had an unprecedented rainfall of about 120 inches. Not a leaf has been affected and the sprayed blocks are looking very healthy, whereas the unsprayed check blocks have lost most of their leaves, and they are at present making wood. In spraying we took particular care to see that the undersurface of all the leaves was sprayed and also the ground round about the plant.

The field we selected was suffering from Black-rot year after year and, to speak the truth, I myself was a bit diffident about its success. I am sorry I cannot give you the actual cost of spraying as we did not keep proper accounts this year, but I am told that it may come to Rs. 25 to Rs. 30 an acre. The strength of the mixture may safely be reduced by half. If this is done and the resin-soda adhesive replaced by casein the cost may come to only about Rs. 15 to 18 per acre.

The experimental field has not been picked yet, and as I told you before, it has very little crop. I intend continuing the experiment next monsoon and will be able to place the result of our experiments at the next Annual Meeting. I thank the Department for all the help given to me and MR. VENKATARAYAN under whose personal supervision the work was conducted.

I am also glad to bring to the notice of the Department that several Indian planters are convinced of the efficacy of spraying and are willing to take it up on their own estates.—JOURN. OF MYSORE AGRIC. AND EXPT. UNION, Vol. V. No. 4.

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* Eugenia Jambolana

AGRICULTURAL EDUCATION

RESEARCH FACILITIES FOR STUDENTS AT ROTHAMSTED.

We have received the following from the Director of the Rothamsted Experiment Station :—

I wish to bring to your notice the facilities offered by the Rothamsted Experimental Station in respect of the research degrees of Cambridge and London Universities, and I would be much obliged if, in future, post-graduate workers, scholarship holders, etc., could have these facilities brought to their notice. We would like to reach not only those who have attended agricultural colleges, but also workers in pure science, as many investigations not directly connected with agriculture can be profitably pursued in an agricultural environment.

The Station comprises laboratories in which research work in the following subjects may be done :—Physics with physical-chemistry, chemistry, insecticides and fungicides, fermentation, botany, bacteriology, protozoology, mycology, algology, entomology, statistics, technique of field experiments.

The Station does not investigate problems outside the study of soil and the growing plant in health and disease ; *i.e.*, no work is done on plant breeding, animal nutrition, agricultural economics, etc. The laboratories have been completely rebuilt within the past 10 years, and the library containing books on agriculture and agricultural science is acknowledged to be one of the most complete in the world. The permanent scientific staff numbers about 40, and at the moment there are 7 post-graduate workers, scholarship holders, etc., conducting research work for the higher degrees mentioned in the enclosed circular.

No personal fees or charges are made to voluntary workers in respect of the use of facilities and the supervision of their work by the head of the department. Owing, however, to the high cost of apparatus and chemicals, the Station may ask in the case of workers sent here by Colonial Governments, Universities, Institutions, etc., for a contribution from these authorities in respect of these charges.

RESEARCH DEGREES OF CAMBRIDGE AND LONDON UNIVERSITIES.

The *University of Cambridge* is prepared to give favourable consideration to each individual case of applicants who desire to carry out at Rothamsted a portion of their work for the following Degrees :—M. Sc., Ph. D.

The *University of London* has accepted the Rothamsted Experimental Station as a "Recognized Institution" from which research workers may submit work done at Rothamsted for the following degrees :— M.Sc., Ph.D., D.Sc.

A brief precis of the most important conditions that must be fulfilled by candidates is given below for general guidance.

Intending workers at Rothamsted are strongly advised in the first instance to send a full account of their academic qualifications and training to the Director, as the candidate will be allowed to enter his thesis only if these qualifications are acceptable to the University Senate.

The general conditions imposed by the University regulations are briefly :—

(1) *Cambridge.* These degrees are granted in full to men only; under certain limitations the titles of degrees are open to women without the privileges which the degree confers in the University.

M.Sc. A minimum residence of five terms at Cambridge and one at Rothamsted. Thesis to be presented not earlier than sixth and not later than twelfth term from term of admission as a research student.

Ph.D. A minimum residence of six terms at Cambridge and three at Rothamsted. Thesis normally to be presented not earlier than ninth term and not later than twelfth term from term of admission as a research student. In special cases permission may be sought to present the thesis after the sixth term.

Note.—Three consecutive terms at Cambridge constitute a year.

(2) *London.* These degrees are open to men and women on equal terms.

M.Sc. and Ph.D. A minimum residence of two calendar years at Rothamsted before submission of the thesis.

D.Sc. Normally the candidate must first hold the M.Sc. degree of the University, but in special cases, on the ground of published work, this regulation may on application be waived. A residence of two years at Rothamsted is required.

A student must ordinarily have taken his first degree not less than four years before the date of his entry for the D.Sc. examination.

Note.—In the case of students registering in October the two-year period may be regarded as ending in the June of the second year. In the case of workers already holding a first degree of London University, they may enter as external students for higher degrees without any requirements as to residence.—AGRIC. JOURN OF INDIA, Vol. XIX. Pt. 3.

APICULTURE.

THE IMPORTANCE OF BEE-FARMING.

W. A. GOODACRE,
Senior Apiary Instructor.

Any advance made in the bee-farming industry does not result only in a greater production of honey. As the scientist CHESHIRE says, "Honey is but a fraction of the result of the bee's labour. They take to truly give, and flowers, seeds, and fruit follow in their train."

As the bee is the chief agent in fertilisation in plant life, the value of the industry from that point of view can hardly be over-estimated. With the days of closer settlement and with bush bees becoming scarce, more and more depends upon the hive bee for this fertilisation work, though that important aspect of the value of the industry is often overlooked. Where honey production may be valued at, say a quarter of a million pounds, the full value of the bee's work may be set down at several millions.

This was amply demonstrated some years ago in Great Britain. When so many hive bees were lost through ravages of the "Isle of Wight disease," the greatest loss occurred in other branches of agriculture through imperfect fertilisation in plant life. As it is in the interest of the bee-farmer to encourage other branches of agriculture, so it is to the interest of other agriculturists to encourage bee-farming. Some knowledge of the bee's work would benefit the agriculturist generally, and some knowledge of plant life as bearing on agriculture would as certainly benefit the bee-farmer.

We may take for an instance, what CHESHIRE has to say about the apple: "The apple, as its blossom indicates, is, strictly, a fusion of five fruits into one—hence called pseudosyncarpous—and demands, for its production in perfection, no less than five independent fertilisations. If none is effected, the calyx, which really forms the flesh of the fruit, instead of swelling, dries and soon drops. An apple often develops, though imperfectly, if four only of the stigmas have been pollen dusted, but it rarely hangs long enough to ripen, the first severe storm sending it to the pigs as a windfall. I had two hundred apples that had dropped during a gale, gathered promiscuously for a lecture illustration, and the cause of falling, in every case but eight, was traceable to imperfect fertilisation. These fruits may be generally known by a deformity; one part has failed to grow, because there has been no diversion of nutrition towards it. Cutting it across with a knife, we find its hollow cheek lies opposite the unfertilised dissepiment containing only shrivelled pips."

In other branches of agriculture somewhat similar items of interest could be quoted, showing how much depends on perfect pollination in the production of seed, &c. Even in plants which provide to a large extent for pollen dusting by wind, the bees greatly assist. In their eagerness to obtain supplies of honey they scatter the pollen to be picked up in the right quarter by the plant for fertilisation purposes.

GIRARD says that "money thrown out of the window in encouraging apiculture will return by the door with the heavy interest."

Where the general agriculturist can give the most encouragement to bee-farming is, at the present time, in the preservation of the honey flora. We often find that through lack of knowledge or thought, the trees, &c., reserved on a holding for shade, &c., are of very little use for bees, whereas with a little knowledge, trees that would have served the same purpose and also have been of importance in encouraging bee farming could have been retained. There are many opportunities too, for reserving good trees on a holding where their growth would not interfere with the interests on the land-holder, and before letting out contracts for ring-barking this point should be considered.

The contention is often raised by the agriculturist when mention is made regarding the preservation of flora that the bee-farmer pays no rent for supplies gathered on the holding, but when we come to consider that the apiarist only gets a fraction of the result of the bee's work in many cases, a different aspect is evident. In spite of this fact bee-farmers would be quite willing to pay if some status were given them in the reservation of flight areas where good flora had been preserved.

Bee-farming in the United States of America has, I understand, made greater progress than any other primary industry during the past twenty years. It is considered that if all the honey for one season's production was loaded in freight cars, it would make a solid train load 50 miles long. They have there a Department of Bee Culture. We have splendid opportunities here for the advance of bee-farming, and the industry, considering its general importance, is deserving of every encouragement.—AGRIC. GAZ., N.S.W., Vol. XXXV. Pt. 5.

CLOVERS FOR THE APIARIST.

TRIALS AT HAWKESBURY AGRICULTURAL COLLEGE.

J. N. WHITTET,

Agrostologist.

For some time past the question whether certain clovers do or do not provide large quantities of nectar for bees has been widely discussed, and in order to throw some light on the matter a trial was conducted last season at the above institution.

The plots were situated just below the College apiary, in order that a close watch might be kept on the trial, and the varieties which were most favoured by the bees noted.

An area of half an acre was planted on 10th April, 1923, using the following varieties:—

Annual Bokhara or Sweet Clover (*Melilotus alba* var.),
Hubam (*Melilotus alba* var.).
Biennial Bokhara (*Melilotus alba*).
Cow-grass (*Trifolium pratense* var. *perenne*).
Perennial Red (*Trifolium pratense* var. *perenne*).
Crimson (*Trifolium incarnatum*).
Berseem or Egyptian (*Trifolium alexandrinum*).

The seed was sown thinly in drills which were 3 feet apart; superphosphate was applied at the rate of 1 cwt. per acre.

The germination on all plots was fair, the rainfall during the period 10th April to 30th November being 15·47 inches. As the average annual rainfall at the College for many years is approximately 30 inches, the rainfall for the eight months was low.

DESCRIPTION OF VARIETIES.

Annual Bokhara and Hubam clovers are selections from the biennial form. They are rapid-growing annuals, attaining in good localities and in good seasons heights of 6 to 7 feet. The plants have white flowers, and evidently secrete large quantities of nectar, as they are frequently visited by bees. Our experience is that there is no difference between Annual Bokhara and Hubam as regards habit of growth and probable nectar content, and as the former gives results as good as the latter, there is no necessity to pay the higher price usually charged for Hubam.

Biennial Bokhara is somewhat similar in its habit of growth to the annual forms, but does not make much headway during its first season. In consequence of this fact a good deal of honey and time would be lost if the biennial form were used in preference to the annual ones, as the former does not flower as profusely as either of the annuals in either its first or second year.

Cow-grass clover is one of the perennial red strains. Like Perennial Red, it retains its vigour under cultivation for some years.

Crimson clover is an annual with a short period of growth. The colour of its flowers varies somewhat from crimson to cream, but the general colour is crimson.

Berseem or Egyptian clover is a fairly strong-growing annual. It is a rapid grower and has pale yellow cylindrical flowers.

COMPARATIVE VALUES OF DIFFERENT VARIETIES.

MR. H. G. SMITH, Apiarist at the College, made the following observations on this trial :—

"Annual Bokhara.—The bees work on this variety from morning till evening. It secretes honey freely and flowers at a favourable season for gathering same."

"Hubam.—Bees favour this variety in about the same measure as Annual Bokhara."

"Biennial Bokhara was not visited by bees to the same extent as the annual forms. At the time this variety flowered, conditions were very favourable for nectar secretion, and it does not appear to be of the same value to the apiarist as Annual Bokhara or Hubam which, even as late as 11th February, 1924, were still in blossom and secreting nectar freely."

"Cow-grass clover and Perennial Red. –No bees were observed working on these varieties."

"Crimson clover and Berseem.—These are of little value as very few bees were seen at work on them."

SEED TREATMENT BENEFICIAL.

In order to promote rapid and effective germination, it is often found necessary to lightly scarify the seed-coat of the various forms of Bokhara clover. Good results in this direction may be obtained by lightly rubbing the seed between sheets of fine sandpaper. If this work is not carried out, the large amount of "hard" seed present may not germinate, and a patchy crop will result.

It is evident that the annual forms of Bokhara clover are the most suitable clovers to grow for honey production.—AGRIC. GAZ. N. S. W. Vol. XXXV. Pt. 5.

MARKET RATES.

MARKET RATES FOR SOME CEYLON PRODUCTS.

(FROM THE CEYLON CHAMBER OF COMMERCE WEEKLY PRICE CURRENT, DATED 9th JUNE, 1924.)

NAME OF PRODUCE		CURRENT PRICE Rs. cts.	at	Rs. cts.	REMARKS
CARDAMOMS					
All round parcel well bleached	per lb.	3 25	,,	3 50	
Do do medium	do	... ...	,,	... ...	
Special assortment O & I only	do	... ...	,,	... ...	
Seeds	do	... ...	,,	... ...	
Green	do	2 65	,,	2 75	
CINNAMON QUILLS—[At Buyer's Stores]					
Ordinary assortment (in bales of 100 lb. nett)	per lb.	0 59	,,	0 66	
No. 1	do	0 63	,,	0 69	
No. 2	do	0 61	,,	0 66	
No. 3	do	0 58	,,	0 64	
No. 4	do	0 55	,,	0 61	
CINNAMON CHIPS—Maradana, (At Buyer's Stores in bags of 56 lb. nett) per candy of 560 lb.		57 00	,,	65 00	
CITRONELLA OIL—(ex-Seller's Stores without packages) ...	per lb.	2 40		2 45	
CACAO—(At Buyer's Stores)					
Estate—Finest	per cwt.	53 00	,,	60 00	
Do Medium	do	30 00	,,	52 00	
Do Common (Black)	do	7 50	,,	20 00	
COCONUT—(Desiccated) Granulated goods (Delivered at Wharf or Buyer's Stores)					
Assortment: Medium 50 per cent. Fine 50 per cent. ...	per lb.	0 19¼	,,	0 20¼	
COCONUT OIL—					
White Oil f.o.b	per ton	580 00	,,	590 00	
Ordinary Oil do	do	537 50	,,	542 50	
COPRA— No. 1 quality					
Calpentyn per candy of 560 lb.		80 00	,,	83 50	
Estate ,, ,,					
Ordinary quality (Maravila) ,, ,,					
Cart Do do ,,					
FIBRES—(At Buyer's Stores)					
Coconut Bristle No. 1	per cwt.	12 90	,,	14 25	
Do No. 2	do				
Coconut Mattress No. 1	do	2 75	,,	3 25	
Do No. 2	do				
Coir yarn Kogalla Nos. 4 to 9	do	12 50	,,	25 00	
Do Colombo Nos. 3 to 7	do	12 50	,,	25 00	

PLUMBAGO		X. B. Rs. cts.		Rs. cts.	B Rs. cts.		Rs. cts.	B. E. Rs. cts.		Rs. cts.
Ordinary Lumps	per ton	300 00	at	350 00	215 00	at	250 00	150 00	at	180 00
Chips	do	175 00	,,	250 00	150 00	,,	200 00	100 00	,,	150 00
Dust	do	100 00	,,	175 00	70 00	,,	125 00	40 00	,,	75 00
Do Flying	do	60 00	,,	145 00	40 00	,,	95 00	25 00	,,	60 00

ANIMAL DISEASE RETURN FOR THE MONTH ENDED 30th JUNE, 1924.

Province, &c.	Disease	No. of Cases up to date since Jan 1st, 1924	Fresh Cases	Recoveries	Deaths	Balance Ill	No. Shot
Western	Rinderpest	478*	61	186	278	6	8
	Foot-and-mouth disease	417	400	149	1	267	—
	Anthrax	5	5	—	5	—	—
	Hæmorrhagic Septicæmia	6	—	2	4	—	—
	* 1 goat						
Colombo Municipality	Rinderpest	327	68	(In	May)		
	Foot-and mouth disease	1	1	"	"		
	Anthrax	—	—				[hand
	Rabies (Dogs)	—	—	Figur	es for	June	not to
Cattle Quarantine Station	Rinderpest	10	7	(In	May)		
	Foot-and-mouth disease	27	4	"	"	Figur	es for
	Anthrax	104*	10	"	"	June	not to
	Pleuro-Pneumonia (in goats)	78†	4	"	"		hand
	* 2 cases amongst cattle,	the rest	amon	gst	goats		
Central	Rinderpest	—	—	—	—	—	—
	Foot-and-mouth disease	135*	58	98	6	31	—
	Anthrax	8	1	—	8	—	—
	Piroplasmosis	4	—	4	—	—	—
	Mange	4	3	1	—	3	—
	Hæmorrhagic Septicæmia	1	1	—	1	—	—
	Rabies (Dogs)	5	—	—	5	—	—
	* 39 cases mouth disease in	goats					
Southern	Rinderpest	—	—	—	—	—	—
	Foot-and-mouth disease	2	—	2	—	—	—
	Anthrax	—	—	—	—	—	—
Northern	Rinderpest	—	—	—	—	—	—
	Foot-and-mouth disease	—	—	—	—	—	—
	Anthrax	—	—	—	—	—	—
	Hæmorrhagic Septicæmia	98*	—	3	95	—	—
	* 23 cases amongst goats						
Eastern	Rinderpest	—	—	—	—	—	—
	Foot-and-mouth disease	1	—	1	—	—	—
	Anthrax	—	—	—	—	—	—
North-Western	Rinderpest	243	—	92	146	—	5
	Foot-and-mouth disease	171	12	159	1	11	—
	Anthrax	12*	9	—	12	—	—
	Rabies (Dogs)	1	—	—	—	—	1
	* 1 dog						
North-Central	Rinderpest	—	—	—	—	—	—
	Foot-and-mouth disease	89	—	89	—	—	—
	Anthrax	—	—	—	—	—	—
Uva	Rinderpest	—	—	—	—	—	—
	Foot-and-mouth disease	—	—	—	—	—	—
	Anthrax	3	—	—	3	—	—
	Black Quarter	15	—	—	15	—	—
Sabaragamuwa	Rinderpest	—	—	—	—	—	—
	Foot-and-mouth disease	354	169	217	2	135	—
	Anthrax	12	—	—	12	—	—
	Hæmorrhagic Septicæmia	3	—	—	3	—	—
	Rabies (Dogs)	2	—	—	1	—	1

†58 amongst 97 goats imported by Mr. C. E. A. Dias on 5th March, 1924.

M. CRAWFORD,
Acting Government Veterinary Surgeon.

Colombo, 8th July, 1924.

METEOROLOGICAL
JUNE, 1924.

Station	Temperature: Mean Daily Shade	Temperature: Difference from Average	Mean Humidity	Mean amount of Cloud 0=clear 10=overcast	Mean Wind Direction during Month	Daily Mean Velocity	Rainfall: Amount	Rainfall: No. of Rainy Days	Rainfall: Difference from Average
	°	°	%			Miles.	Inches		Inches
Colombo Observatory	81·0	—0·6	82	8·8	SW	159	6·98	22	- 0·80
Puttalam	81·5	—0·7	78	5·4	SW	307	2·42	11	+0·72
Mannar	84·6	—0·2	74	7·4	SSW	281	0·02	1	- 0·55
Jaffna	83·0	—0·8	77	6·6	SW	491	0·02	1	- 0·66
Trincomalee	85·2	—0·4	66	7·2	WSW	291	0·00	0	- 1·30
Batticaloa	84·7	—0·5	66	5·8	VAR.	101	0·25	2	- 0·76
Hambantota	81·6	0	80	5·0	SSW	396	0·66	7	- 1·76
Galle	80·8	+0·2	82	5·8	WNW	290	5·49	20	- 2·79
Ratnapura	80·4	—0·2	86	7·6	—	—	12·93	21	- 7·03
Anu'pura	82·1	—1·1	76	6·6	—	—	0·29	4	- 1·09
Kurunegala	79·9	—1·1	81	8·7	—	—	6·57	20	- 1·62
Kandy	76·5	—0·1	80	8·1	—	—	6·67	17	- 2·97
Badulla	74·5	—0·9	77	7·3	—	—	1·46	7	- 0·83
Diyatalawa	71·0	+0·5	76	7·5	—	—	0·53	6	- 1·60
Hakgala	62·1	+0·3	81	7·7	—	—	4·47	15	- 3·23
N. Eliya	61·0	+1·0	84	9·0	—	—	7·56	19	- 5·29

The Weather experienced during the month was typical of a monsoon current deficient both in strength and humidity.

In direction the wind was normal, and as is to be expected with predominant south-westerly winds, the rainfall was heaviest on the slopes of the hills facing the wind. Extensive areas to the North and East were rainless.

Rainfall was below normal over the greater part of the Island and most in deficit to the West of the Hills where it is usually heaviest. It was slightly above normal from the Henaratgoda District northwards throughout the Western half of the North-Western Province.

A mark of the scanty nature of the rainfall on the windward slopes of the hills is that in this the Wettest Month of the year for that area not a return has been received that records a fall of five inches or over in the day.

The meteorological elements above normal were Air Pressure, and the amount of cloud while the Temperature in the shade, Humidity and Wind Force were below.

J. E. EVANS,
Actg. Supdt., Observatory.